Irradiated research and development samples introduced into the hot cell could be processed or examined using manipulators within the hot cell. Samples could also enter the research and development suite of lab rooms through the hot cell port into a hot cell or glovebox. From there, they could be moved to additional research and development laboratory rooms within a controlled environment for detailed analysis and testing.

Support areas would include ventilation, maintenance, change rooms, quality assurance and quality control, lunch and break rooms, storage, conference rooms, basement stairwells, equipment elevators, and utility distribution. A small machine shop would accommodate light machining activities, but would not be intended to involve radioactive materials. A portion of the support functions, especially utilities, would be located in a basement portion of the building. The basement would be located under the half of the building that would not experience high weight loads (i.e., hot cell, cask receiving area).

Solid waste would be collected, packaged, and stored at a central location. Liquid waste would be processed at the point of generation (e.g., hood/glovebox) or would be collected in a retention tank for characterization and eventual transfer to the effluent treatment facility.

2.4 DESCRIPTION OF TRANSPORTATION ACTIVITIES

2.4.1 Purchase of Plutonium-238 from Russia

Under the No Action Alternative (see Section 2.5.1), DOE would continue exercising its option to purchase Russian plutonium-238 (if available) to meet the needs of future U.S. space exploration missions. In 1992, DOE signed a contract permitting the purchase from Russia of up to 40 kilograms (88.2 pounds) of plutonium-238. To date, DOE has purchased 9 kilograms (19.8 pounds). In 1997, DOE extended the contract for another 5 years, so this option remains viable. It is unclear, however, whether this option would remain reliable or viable once the existing contract expires (DOE 1997). The impacts associated with the purchase of plutonium-238 from Russia are discussed in Section 4.2.1.1.

2.4.2 Transportation of Plutonium-238 from St. Petersburg, Russia, to the Los Alamos National Laboratory

Plutonium-238 purchased from Russia would have to be transported from St. Petersburg to a U.S. port of entry, and from there to LANL where it would be used in the fabrication of radioisotope power systems and heating units. The impacts of the transportation of a total of 40 kilograms (88.2 pounds) of plutonium-238 are estimated in the *Environmental Assessment of the Import of Russian Plutonium-238* (DOE 1993) and are summarized in Section 4.2.1.1 of this NI PEIS. The impacts associated with transporting 175 kilograms (385 pounds) (5 kilograms [11 pounds] per year for the 35-year evaluation period) of plutonium-238 have been determined by extrapolation and are included in the same section.

2.4.3 Transportation of Neptunium-237 from Savannah River Site to Candidate Storage Facilities

Under the No Action Alternative (see Section 2.5.1) DOE would transport neptunium-237 oxide from SRS to a storage facility off site. Storage canisters containing the neptunium-237 oxide would be loaded into approved shielded shipping containers or casks at SRS and shipped to the designated storage facilities for long-term storage.

Truck transportation of neptunium-237 from SRS to the proposed storage facilities is assumed in this NI PEIS. The neptunium-237 would be transported in robust Type B transportation casks. Type B casks are used to transport nuclear materials with the highest radioactivity levels, and are designed to protect and retain their contents under transportation accident conditions. According to DOE policy, which requires compliance with

applicable Federal regulations regarding domestic shipments of radioactive materials, transportation of neptunium-237 in Type B casks would comply with the requirements of 10 CFR Part 71, "Packaging and Transportation of Radioactive Materials," and 49 CFR Part 173, "Shippers - General Requirements for Shipments and Packagings."

The container that would be used to transport neptunium-237 has not been proposed, but would be a Type B container similar to the Chalfont container 9975. The 9975 container includes a 132-liter (35-gallon) drum, insulation, a primary containment vessel, a secondary containment vessel, lead shielding, and aluminum honeycomb spacers. The neptunium-237 would be sealed into a can, which would be placed on a honeycomb spacer inside the stainless steel primary containment vessel. The primary containment vessel would be bolted closed and placed into a similarly constructed, but larger, secondary containment vessel. The secondary containment vessel would be bolted closed and loaded into a drum equipped with lead shielding to reduce radiation levels and fireboard insulation to protect the containment vessels in the unlikely event of a severe impact. A description of the Chalfont container 9975 is provided in Appendix J.

DOE anticipates that neptunium-237 would be transported through use of the Transportation Safeguards System and shipped using SST/SGTs. The SST/SGT, a fundamental component of the Transportation Safeguards System, is a specially designed component of an 18-wheel tractor-trailer vehicle. Although details of vehicle enhancements and some operational aspects are classified, key characteristics of the SST/SGT system include the following:

- Enhanced structural characteristics and a highly reliable tie-down system to protect cargo from impact
- Heightened thermal resistance to protect the cargo in case of fire (newer SST/SGT models)
- Established operational and emergency plans and procedures governing the shipment of nuclear materials
- Various deterrents to prevent unauthorized removal of cargo
- An armored tractor component that provides courier protection against attack and contains advanced communications equipment
- Specially designed escort vehicles containing advanced communications and additional couriers
- 24-hour-a-day real-time communications to monitor the location and status of all SST/SGT shipments via DOE's Security Communication system
- Couriers, who are armed Federal officers, receive rigorous specialized training and are closely monitored through DOE's Personnel Assurance Program
- Significantly more stringent maintenance standards than those for commercial transport equipment
- Conduct of periodic appraisals of the Transportation Safeguards System operations by the DOE Office of Defense Programs to ensure compliance with DOE orders and management directives, and continuous improvement in transportation and emergency management programs

Additional details are presented in Appendix J.

2.4.4 Transportation of Mixed Oxide Fuel from Europe to the Fast Flux Test Facility

As discussed in Section 2.3.1.1.3, a 15-year supply of mixed oxide fuel may be available from Germany to operate FFTF. Approximately 205 mixed oxide fuel assemblies were fabricated in Europe for use in Germany's SNR–300 sodium-cooled, breeder reactor before the German government suspended the reactor's operation. SNR–300 mixed oxide fuel is very similar in both composition and construction to FFTF fuel. The 205 SNR–300 mixed oxide fuel assemblies, if reconfigured for FFTF, could be used to fabricate about 150 to 160 FFTF fuel assemblies. This amount could supply two FFTF core loads for approximately 15 years of FFTF operation at the 100 megawatts thermal power level with occasional excursions to the 400 megawatts thermal power level on an as-needed basis (as proposed for this mission).

The inventory of unused SNR–300 mixed oxide fuel is now stored at Hanau, Germany, and Dounreay, Scotland. If a decision were made to use SNR–300 fuel in FFTF, security measures would be implemented to prevent unauthorized removal of the mixed oxide fuel during transportation to the United States. The requirements to ensure the safety and security of transatlantic mixed oxide fuel shipments are listed in: *The Convention on the Physical Protection of Nuclear Material*, International Atomic Energy Agency publication INFCIRC 274 (IAEA 1997); *The Physical Protection of Nuclear Material*, International Atomic Energy Agency publication INFCIRC 225 (IAEA 1999); the *Code for the Safe Carriage of Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes in Flasks on Board Ships* (IMO 1993); DOE orders; and 10 CFR Part 73. DOE estimates that as many as 11 shipments from Europe would be required. The initial shipment would transport the FFTF mixed oxide fuel lead test assembly, and the following 5 to 10 shipments would transport the SNR–300 fuel assemblies reconfigured for FFTF use.

SNR–300 mixed oxide fuel could be brought into many U.S. commercial and military ports. A port-selection process was used by DOE in its *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (Foreign Research Reactor Spent Nuclear Fuel EIS)* (DOE 1996). The criteria used for screening ports in the *Foreign Research Reactor Spent Nuclear Fuel EIS* were: (1) appropriate port experience; (2) safe port transit to open ocean; (3) appropriate port facilities for safe receipt, handling, and transshipment; (4) ready intermodal access; and (5) low human population of the ports and along transportation routes. DOE used these same criteria to identify ports for receiving mixed oxide fuel from Europe. The application of these criteria for mixed oxide fuel is discussed in Section J.3.6.1.

In the *Foreign Research Reactor Spent Nuclear Fuel EIS* Record of Decision, DOE decided to use military ports to take advantage of their capabilities to increase the safety and security of the spent fuel transportation process. DOE concluded that the use of military ports provides additional confidence in the safety of shipments due to the increased security. Since the security issues are far greater for fresh mixed oxide fuel than for spent nuclear fuel because of the potential for proliferation, DOE would use a military port to bring the SNR–300 mixed oxide fuel into the country.

Based on a review of the *Foreign Research Reactor Spent Nuclear Fuel EIS* (DOE 1996), the following military ports were considered:

- In the eastern United States: Charleston Naval Weapons Station, South Carolina; Military Ocean Terminal Sunny Point, North Carolina; Mayport, Florida; Kings Bay, Georgia; Pensacola, Florida; Yorktown, Virginia; and Hampton Roads, Virginia

- In the western United States: Military Ocean Terminal Bay Area, California; Bremerton, Washington; Everett, Washington; Port Hueneme, California; and Port Townsend, Washington

Other military ports that could be considered in a formal port selection process include, but are not limited to: Naval Weapons Station Seal Beach, California; Naval Submarine Base, North Island, California; Naval Amphibious Base Coronado, California; Naval Station San Diego, California; Naval Station Ingleside, Texas; Naval Station Pascagola, Mississippi; Naval Air Station Pensacola, Florida; Naval Weapons Station Earle, New Jersey; and Naval Submarine Base New London, Connecticut.

The overland transportation impacts would be higher if mixed oxide fuel were accepted at an east coast port rather than a west coast port. However, accepting mixed oxide fuel at an east coast port would reduce time and eliminate the potential security risk when transiting the Panama Canal. Charleston Naval Weapons Station, an east coast port, was used for the purpose of transportation impact analysis (see Section J.6.2). If Alternative 1 (Restart FFTF) were selected for implementation, and if it were decided to import mixed oxide fuel, DOE would conduct an appropriate NEPA review prior to importation of mixed oxide fuel. The analysis would consider a variety of ports on the east and west coasts. It also would consider the potential impacts of traversing both global commons (i.e., portions of the ocean not within the territorial boundary of any nation), in accordance with Executive Order 12114 (44 FR 1957), and inland waters (such as Puget Sound), as well as shipboard fires, package handling, truck transportation, and logistical and safeguard and security concerns associated with transporting mixed oxide fuel.

Use of a military port to receive SNR–300 mixed oxide fuel would require shipment via chartered ships. The ships that would be used to transport SNR–300 mixed oxide fuel to the United States would be of the type used to transport spent nuclear fuel or mixed oxide fuel internationally. These specially equipped ships are called purpose-built vessels.

Purpose-built vessels, as used in this NI PEIS, are those vessels specifically designed to transport nuclear fuel casks. These vessels operate as dedicated vessels and, therefore, are not used to transport any other cargoes. Casks are loaded directly into the holds of the vessels because the cargo compartments contain hardware that mates to the tie-down fixtures on the casks. If a vessel has no crane, dockside cranes are used for loading and unloading. The cargo compartments are typically intended to handle a specific type of cask, and other cask types cannot be used without making modifications to the tie-down hardware.

The purpose-built vessels are equipped with double bottoms and hulls, watertight compartments, special firefighting systems, and collision-damage-resisting structures within the main hull, as well as special security features and satellite tracking systems. The crew is trained in appropriate cargo-handling techniques and in emergency response.

At present, purpose-built vessels are operated by Pacific Nuclear Transport Services of Japan, by British Nuclear Fuels, Limited, and by the Swedish Nuclear Fuel and Waste Management Company. They are used to move nuclear fuel between operating nuclear power plants and nuclear fuel reprocessing facilities operated by Cogema and British Nuclear Fuels, Limited, or in Sweden's case, the repository in Forsmark. Beginning in 1998, purpose-built vessels have transported spent nuclear fuel from foreign research reactors to the Charleston Naval Weapons Station. Additionally, in 1999 purpose-built vessels delivered mixed oxide fuel from the United Kingdom to Japan. There are no U.S.-owned purpose-built vessels for nuclear fuel transport.

DOE anticipates that the SNR–300 mixed oxide fuel would be transported overland from the seaport to FFTF using the same Transportation Safeguards System that would be required for the transportation of neptunium-237 (see Section 2.4.3).

The environmental impacts associated with importing SNR–300 mixed oxide fuel from Europe are discussed in Section 4.3 and Appendix J.

2.4.5 Transportation of Neptunium-237 from Savannah River Site to Target Fabrication Facilities

The neptunium-237 required for target fabrication in the production of plutonium-238 is currently stored at SRS. Therefore, transportation of neptunium-237 oxide from SRS to target fabrication facilities off site (REDC, FDPF, FMEF) would be required. Storage canisters containing the neptunium-237 would be loaded into approved shielded shipping containers or casks at SRS and shipped to the target fabrication facilities. Transportation of neptunium-237 from SRS to these facilities for long-time storage is discussed in Section 2.4.3.

2.4.6 Transportation of Nonirradiated and Irradiated Targets

Transportation of nonirradiated neptunium-237 targets from the target fabrication facility to the irradiation facility and irradiated targets from the irradiation facility back to the fabrication facility for processing would use Type B casks certified for the safe shipments of the neptunium-237 targets. The casks used would be similar in size and construction to a spent nuclear fuel cask. Nonirradiated neptunium-237 targets would be transported in SST/SGTs. Irradiated neptunium-237 targets could be transported in commercial trucks. The analysis in this NI PEIS assumes transportation in commercial trucks to maximize the environmental impacts. The cask selection and environmental issues are discussed in Appendix J.

2.4.7 Transportation of Plutonium-238 Product to the Los Alamos National Laboratory

After postirradiation processing at the target processing facility, the plutonium-238 product in oxide form would be packaged and shipped to LANL. The 5320 package, designed for surface transportation of americium or plutonium, would be used to carry plutonium oxide to LANL. The 5320 package is a dome-topped upright cylinder that is mounted on a baseplate supported by casters. As explained in Appendix J, Section J.3.3.3, the plutonium-238 would be loaded into an EP–60 product canister, a stainless steel shell confinement vessel used to load the product into the package safely and conveniently. The EP–60 would be seal-welded into the removable stainless steel shell primary containment vessel, the EP–61. The EP–61 would be placed into the secondary containment vessel, the EP–62. The stainless steel EP–62 has a removable bolted closure lid. The gasketed flange of the EP–62 satisfies the containment requirements for both normal transport and hypothetical accident conditions. Plutonium oxide would be transported using the Transportation Safeguards System and would be shipped using SST/SGT (see Section 2.4.3).

2.4.8 Transportation of Materials for Medical Isotope Production

The raw material for target fabrication would typically be acquired from ORNL, where enrichment processes are conducted to produce high purity target material suitable for production of medical isotopes. The raw material would be shipped from ORNL to Hanford or to the new generic support facility at an existing but undefined DOE site.

Transportation of materials for medical and industrial isotope production and research and development would take place at Hanford between FFTF and the Hanford RPL/306–E facilities or FMEF. At the existing DOE site, transportation would take place between the new generic support facility and either the new low-energy accelerator or the new research reactor.

At Hanford, two different target irradiation vehicle assemblies would be used—the Long-Term Irradiation Vehicle Assembly (up to 3.7 meters [12 feet] in length) and the Rapid Radioisotope Retrieval System Target Carrier (less than 30 centimeters [1 foot] in length). Irradiated pins or short target carriers would be shipped from the irradiation facility to the processing facility using a Type B, accident-resistant shipping cask. The elements (or pins) for the Long-Term Target Irradiation Vehicle Assemblies would be segmented in the FFTF

Interim Examination and Maintenance cell, if necessary, or could be inserted directly into the shipping cask. The Rapid Retrieval System Target Vehicle Assemblies would be inserted into a smaller "shielded pig" package, which would be inserted into the shipping cask or, ideally and as a design goal, the irradiated target carriers would be loaded directly into the shipping cask from the reactor.

At the existing DOE site, irradiated targets and research and development material would be transported in a "shielded pig" package from either the new low-energy accelerator or the new research reactor to the new generic support facility.

A variety of casks would be used to ship the separated isotopes from the processing facility to the destination (i.e., the pharmaceutical distributor). Some land and air shipments would use DOT-specified casks such as CI-20WC-2, and others would require larger Type B casks.

An existing licensed irradiated fuel shipping cask (the T-3) is available to transport material used for research and development. This cask can accommodate shipments of pins or FFTF fuel assemblies as well as nonfuel experiments and materials.

2.5 DESCRIPTION OF ALTERNATIVES

A perspective on the programmatic activities associated with the options under each alternative is presented in **Table 2–3**. Individual alternatives are described in the following sections. The environmental impacts associated with each alternative and its options are discussed in Chapter 4 and are summarized in Section 2.7.1.

Table 2–3 Alternatives and Options Matrix

Activity	Irradiation Facility and Site	Target Fabrication and Processing Facility Site	No Action Alternative Options				Alternative 1[a] Options						Alternative 2[b] Options									Alternative 3[c] Options			Alternative 4[d] Options			Alternative 5[e]
			1	2	3	4	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	1	2	3	1	2	3	
Store neptunium-237 as oxide		REDC at ORNL		●																								
		CPP–651 at INEEL			●																							
		FMEF at Hanford				●																						
Purchase plutonium-238			●	●	●	●																						
Irradiate targets for plutonium-238 production	FFTF at Hanford: mixed oxide fuel: 21 years; highly enriched uranium: 14 years						●	●	●																			
	FFTF at Hanford: mixed oxide fuel: 6 years; highly enriched uranium: 29 years									●	●	●																
	ATR at INEEL												●	●	●													
	CLWR (generic site)															●	●	●										
	ATR at INEEL plus HFIR at ORNL																		●	●	●							
	New high-energy accelerator at generic DOE site																					●	●	●				
	New research reactor (generic DOE site)																								●	●	●	
Store neptunium-237 and fabricate and process targets for plutonium-238 production		REDC at ORNL					●			●			●			●			●			●			●			
		FDPF and CPP–651[f] at INEEL						●			●			●			●			●			●			●		
		FMEF at Hanford							●			●			●			●			●			●			●		
Irradiate targets for medical and industrial isotope production and perform research and development activities	FFTF at Hanford: mixed oxide fuel: 21 years; highly enriched uranium: 14 years						●	●	●																			
	FFTF at Hanford: mixed oxide fuel: 6 years; highly enriched uranium: 29 years									●	●	●																
	New low-energy accelerator at generic DOE site																					●	●	●				
	New research reactor at generic DOE site																								●	●	●	
Fabricate and process targets for medical and industrial isotope production and perform research and development activities		FMEF at Hanford							●			●																
		RPL/306–E					●	●		●	●																	
		New facility (generic DOE site)																				●	●	●	●	●	●	
Maintain FFTF in standby status	FFTF at Hanford		●	●	●	●																						
Deactivate FFTF	FFTF at Hanford												●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

a. Alternative1, Restart FFTF.
b. Alternative 2, Use Only Existing Operational Facilities.
c. Alternative 3, Construct New Accelerator(s).
d. Alternative 4, Construct New Research Reactor.
e. Alternative 5, Permanently Deactivate FFTF (with No New Missions).
f. CPP–651 would be used only for storage.

2.5.1 No Action Alternative

Under the No Action Alternative (maintain status quo), FFTF would be maintained in standby status for all or a portion of the 35-year evaluation period for operations covered in this NI PEIS. For the purpose of analysis in this NI PEIS, the maximum period of 35 years was assumed. Ongoing operations at existing facilities (as described in Chapter 3, Affected Environment) would continue under this alternative. DOE would not establish a domestic plutonium-238 production capability, but could instead continue to purchase Russian plutonium-238 to meet the needs of future U.S. space missions. For the purpose of analysis in this NI PEIS, DOE assumed that it would continue to purchase plutonium-238 to meet the space mission needs for the 35-year evaluation period. DOE recognizes, however, that any purchase beyond what is currently available to the United States through the existing contract will require additional NEPA review. DOE would continue its medical and industrial isotope production and civilian nuclear energy research and development activities at the current operating levels of existing facilities. A consequence of a No Action decision would be the need to determine the future of the neptunium-237 stored at SRS. Therefore, the impacts of possible future transportation and storage of neptunium-237 are evaluated as part of the No Action Alternative. Four options are identified. If DOE decides not to establish a domestic plutonium-238 production capability in the future, then neptunium-237 would have no programmatic value and Option 1 would be selected. Conversely, if DOE decides to maintain the capability to establish a domestic plutonium-238 capability in the future, the inventory of neptunium-237 must be retained. In this case, Option 2, 3, or 4 could be selected.

- **Option 1.** Under this option, DOE would follow its current stabilization strategy for the neptunium-237, currently stored in solution form at SRS. The current plan is to stabilize the material to oxide, as described in the Supplemental Record of Decision for the *Final Environmental Impact Statement, Interim Management of Nuclear Materials at SRS* (DOE 1995c; 62 FR 61099). This Record of Decision would be amended or new NEPA analysis would be performed, if necessary.

- **Options 2 through 4.** Under these options, the neptunium-237 oxide would be transported from SRS to one of three candidate DOE sites for up to 35 years of storage. For the purpose of analysis in this NI PEIS, the maximum period of 35 years was assumed. Option 2 would provide storage at ORNL's REDC facility, Option 3 at INEEL's Building CPP–651, and Option 4 at Hanford's FMEF.

2.5.2 Alternative 1—Restart FFTF

Under Alternative 1, FFTF at Hanford would be restarted and operated for the 35-year evaluation period. FFTF would be used to irradiate targets for medical and industrial isotopes production, plutonium-238 production, and civilian nuclear energy research and development irradiation requirements. Ongoing operations at existing facilities (as described in Chapter 3, Affected Environment) would continue.

Targets for medical and industrial isotope production would be fabricated in one or more facilities at Hanford. Target material would typically be acquired from ORNL, where enrichment processes are conducted to produce high-purity target material suitable for production of medical isotopes. The targets would be irradiated at FFTF and then returned to the fabrication facility for postirradiation processing. From there, the isotope products would be sent directly to commercial pharmaceutical distributors.

Targets for plutonium-238 production would be fabricated in one of three candidate facilities at ORNL, INEEL, or Hanford. The material needed for target fabrication (neptunium-237) would be transported from SRS. The nonirradiated targets would be transported and irradiated at FFTF and then transported back to the fabricating facilities for postirradiation processing. The separated plutonium-238 would be transported to LANL for fabrication into radioisotope power systems and heating units.

Under Alternative 1, raw materials, nonirradiated targets, irradiated targets, and processed materials would be transported among the locations selected for raw target material acquisition, material storage, target fabrication, target irradiation, and postirradiation processing, and eventually to the final destinations for the medical and industrial isotopes and the plutonium-238 product or various research and development test sites.

FFTF could produce high-energy neutrons and a large flux level (10^{15} neutrons per square centimeter per second) that can be tailored to nearly any desired energy level. FFTF would provide the greatest flexibility for both isotope production and nuclear-based research and development among the baseline configurations for all of the proposed alternatives. Due to its large core size, flux spectrum, demonstrated testing capability, and rated power level, it would be able to concurrently support the projected plutonium-238 production needs, production of medical and industrial isotopes, and civilian nuclear energy research and development related to a broad range of materials, advanced reactors, advanced fuels, and waste transmutation.

The six options under this alternative are associated with the type of nuclear fuel to be used for FFTF operations and the specific facilities to be used for target fabrication and processing. The first three options (Options 1 through 3) would involve operating FFTF with a mixed oxide fuel core for the first 21 years and a highly enriched uranium fuel core for the remaining 14 years. The last three options (Options 4 through 6) would involve operating FFTF with a mixed oxide fuel core for the first 6 years and a highly enriched uranium fuel core for the remaining 29 years. FFTF can provide similar irradiation services with either a mixed oxide fuel core or a highly enriched uranium fuel core. The reasons for these options in FFTF core fuel are provided in Section 2.3.1.1.3. Potential impacts from the deactivation of FFTF at the end of its operating life are not explicitly covered under this alternative, but are addressed under Alternative 5 (Section 2.5.6).

The options involving storage, fabrication, postirradiation processing, and transportation are discussed below.

- **Options 1 and 4.** REDC at ORNL would be used to fabricate and process the neptunium-237 targets required for plutonium-238 production. The neptunium-237 transported from SRS to ORNL would be stored in REDC. The plutonium-238 product would be transported from ORNL to LANL. Hanford's RPL/306–E facilities would be used to fabricate and process targets for medical and industrial isotope production and for research and development, as well as to store the materials needed to fabricate these targets.

- **Options 2 and 5.** FDPF at INEEL would be used to fabricate and process the neptunium-237 targets for plutonium-238 production. The neptunium-237 transported from SRS to INEEL would be stored in FDPF or Building CPP–651 at INEEL. The plutonium-238 product would be transported from INEEL to LANL. Hanford's RPL/306–E facilities would be used to fabricate and process targets for medical and industrial isotope production and for research and development, as well as to store the materials needed to fabricate these targets.

- **Options 3 and 6.** FMEF at Hanford would be used to fabricate and process both neptunium-237 targets for plutonium-238 production and targets for the production of medical and industrial isotopes. The neptunium-237 transported from SRS to Hanford and the other target materials transported from other offsite facilities to Hanford would be stored in FMEF. The plutonium-238 product would be transported from Hanford to LANL for fabrication into heat sources for radioisotope power systems.

2.5.3 Alternative 2—Use Only Existing Operational Facilities

Under Alternative 2, DOE would use existing operating DOE reactors or U.S. commercial nuclear power plants to produce plutonium-238 for future space missions. The production of medical and industrial isotopes

and support of civilian nuclear energy research and development in DOE reactors and accelerators would continue at the No Action Alternative levels.

The currently operating DOE reactors, HFIR and ATR, cannot fully meet the projected long-term needs for medical isotope production and civilian nuclear energy research and development with or without adding the plutonium-238 production mission. Depending on the combination of facilities used in Alternative 2, HFIR and ATR could continue their current support of the medical and industrial isotope and research and development missions, including some near-term growth, while accommodating the production of plutonium-238. Under other scenarios, some near-term growth in medical and industrial isotope production and civilian nuclear energy research and development could be limited by the addition of plutonium-238 production. In any case, non-DOE use of these facilities would be affected by the addition of the plutonium-238 mission. If a commercial reactor were used for plutonium-238 production, the DOE facilities would be unaffected and would continue operating as discussed under the No Action Alternative.

Another component of Alternative 2 is permanent deactivation of FFTF. Permanent deactivation of FFTF (Alternative 5) would occur in conjunction with any of the options under Alternatives 2, 3, or 4. Ongoing operations at existing facilities (as described in Chapter 3, Affected Environment) would continue under Alternative 2.

Targets for plutonium-238 production would be fabricated in one of three facilities at ORNL, INEEL, or Hanford. The material needed for target fabrication (neptunium-237) would be processed and transported from SRS to the fabrication facilities. The targets would be irradiated at existing reactor facilities (HFIR, ATR, a CLWR, as described in Section 2.3.1) and would be transported back to the fabricating facilities for postirradiation processing.

Under Alternative 2, nonirradiated targets, irradiated targets, and processed materials would be transported among the locations selected for storage, target fabrication, target irradiation, and postirradiation processing, and the plutonium-238 product would be transported to LANL.

Nine options are proposed under this alternative. Options 1 through 3 involve the irradiation of targets in ATR at INEEL. Options 4 through 6 involve the irradiation of targets in a generic CLWR. Options 7 through 9 involve the irradiation of targets in both INEEL's ATR and ORNL's HFIR. These options and the associated target fabrication, postirradiation processing, and transportation activities are discussed below.

- **Option 1.** REDC at ORNL would be used to store the neptunium-237 transported from SRS to ORNL and to fabricate and process the targets irradiated at ATR. Option 1 also would involve transportation of the neptunium-237 targets from ORNL to INEEL for irradiation in ATR, transportation of the irradiated targets from INEEL back to ORNL for postirradiation processing, and subsequent transportation of the plutonium-238 product from ORNL to LANL following postirradiation processing.

- **Option 2.** FDPF at INEEL would be used to store the neptunium transported from SRS to INEEL and to fabricate and process the targets (irradiated at ATR). Building CPP–651 would be used for storage. Option 2 also would involve transportation of the plutonium-238 product from INEEL to LANL following postirradiation processing.

- **Option 3.** FMEF at Hanford would be used to fabricate and process the targets (irradiated at ATR) and to store the neptunium-237 transported from SRS to Hanford. Option 3 also would involve transportation of the neptunium-237 to Hanford for target fabrication, transportation of the targets

from Hanford to INEEL for irradiation, transportation of the irradiated targets back to Hanford for postirradiation processing in FMEF, and subsequent transportation of the plutonium-238 product from Hanford to LANL.

- **Option 4.** REDC at ORNL would be used to store the neptunium-237 transported from SRS to ORNL and to fabricate and process the targets (irradiated at a generic CLWR). Option 4 also would involve transportation of the neptunium-237 targets from ORNL to the generic CLWR location for irradiation, transportation of the irradiated targets back to ORNL for postirradiation processing, and transportation of the plutonium-238 product from ORNL to LANL.

- **Option 5.** FDPF at INEEL would be used to store the neptunium transported from SRS to INEEL and to fabricate and process the targets (irradiated at a generic CLWR). Building CPP–651 would also be used for storage. In addition, Option 5 would involve transportation of the neptunium-237 targets from INEEL to the generic CLWR location for irradiation, transportation of the irradiated targets back to INEEL for postirradiation processing, and transportation of the plutonium-238 product from INEEL to LANL.

- **Option 6.** FMEF at Hanford would be used to store the neptunium-237 transported from SRS to Hanford and to fabricate and process the targets (irradiated at a generic CLWR). Option 6 also would involve transportation of neptunium-237 to Hanford for target fabrication, transportation of the targets from Hanford to the generic CLWR location for irradiation, transportation of the irradiated targets back to Hanford for postirradiation processing, and transportation of the plutonium-238 product from Hanford to LANL.

- **Option 7.** REDC at ORNL would be used to store the neptunium-237 transported from SRS to ORNL and to fabricate and process the targets (irradiated at ATR and HFIR). Option 7 also would involve transportation of the neptunium-237 targets from ORNL to the reactors for irradiation, transportation of the irradiated targets back to ORNL for processing, and transportation of the plutonium-238 product from ORNL to LANL.

- **Option 8.** FDPF at INEEL would be used to store the neptunium transported from SRS to INEEL and to fabricate and process the targets (irradiated at ATR and HFIR). Building CPP–651 would be used for storage. Option 8 also would involve transportation of the neptunium-237 targets from INEEL to the reactors for irradiation, transportation of the irradiated targets back to INEEL for postirradiation processing, and transportation of the plutonium-238 product from INEEL to LANL.

- **Option 9.** FMEF at Hanford would be used to store the neptunium-237 transported from SRS to Hanford and to fabricate and process the targets (irradiated at ATR and HFIR). Option 9 also would involve transportation of neptunium-237 to Hanford for target fabrication, transportation of the targets from Hanford to the reactors for irradiation, transportation of the irradiated targets back to Hanford for postirradiation processing, and transportation of the plutonium-238 product from Hanford to LANL.

2.5.4 Alternative 3—Construct New Accelerator(s)

Under Alternative 3, one or two new accelerators would be used for target irradiation for the evaluation period of 35 years. The new accelerator(s), which would be constructed at an existing DOE site(s), would be used to irradiate all of the targets (i.e., for production of plutonium-238, isotopes for medical and industrial uses, and materials testing for research and development). Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue.

The targets for plutonium-238 production would be fabricated in one of the three candidate facilities at ORNL, INEEL, or Hanford. The material needed for the target fabrication (neptunium-237) would be transported from SRS to the fabrication facilities. The targets would be irradiated at the new high-energy accelerator facility and transported back to the target fabrication facilities for postirradiation processing.

Targets for medical and industrial isotope production would be fabricated in a new support facility located at the same site as the low-energy accelerator. The targets would be irradiated in the low-energy accelerator and returned to the new support facility for postirradiation processing. Site selection for Alternative 3 is not evaluated as part of this NI PEIS. Because Alternative 3 is evaluated at a generic DOE site, no credit was taken for any support infrastructure existing at the site, and it was postulated that a new support facility would be required to support operation of the low-energy accelerator and its missions and the high-energy accelerator civilian nuclear energy research and development missions if both accelerators were located on the same site. While this approach bounds this NI PEIS for the implementation of Alternative 3, it overstates the impacts because this NI PEIS integrates the impacts associated with constructing new support facilities and infrastructure that may be available at the existing DOE site. In the event that Alternative 3 or the low-energy accelerator alone were selected by the Record of Decision for subsequent consideration, follow-on NEPA reviews would evaluate potential locations for either one or both of the accelerators. It is unlikely that DOE would consider locating the new low-energy or high-energy accelerator on a DOE site that does not have existing infrastructure capable of supporting all or most of the mission requirements.

Under Alternative 3, nonirradiated targets, irradiated targets, and processed materials would be transported between the locations selected for storage, target fabrication, target irradiation, postirradiation processing, and the final destination of the plutonium-238. Alternative 3 also would include decontamination and decommissioning of the accelerator(s) and the support facility when the missions are completed, as well as deactivation of FFTF at Hanford.

The low-energy accelerator would serve as a dedicated isotope production facility. Due to the nature of this type of accelerator, it could only produce a limited number of isotopes (listed in Table 1–1), has no ability to satisfy the plutonium-238 needs, and has a very limited ability to support the proposed nuclear-based research and development needs. The preconceptual design of the high-energy accelerator presented in Appendix F focused on supporting the plutonium-238 production mission. The design of the high-energy accelerator could be refined and expanded to perform additional missions such as the production of a select set of medical and industrial radioisotopes. In addition, DOE is aware of longer-term concepts that would apply high-energy accelerators to produce “tuneable” neutrons in a subcritical assembly. Such a facility could be used to address some of the missions more familiar to reactor facilities and may hold considerable promise for future science and technology research. A facility of this nature could provide unique capabilities in areas such as the testing of many different nuclear system coolant, fuel, and material interactions. The changes required to add additional capability to the high-energy accelerator could be provided, but they would increase the size of the facility, add complexity to the facility design and operation, increase the cost of construction and operation, and potentially require more time for design and construction.

The three options under this alternative and their associated target fabrication, postirradiation processing, and transportation activities are discussed below.

- **Option 1.** REDC at ORNL would be used to fabricate and process the neptunium-237 targets required for plutonium-238 production. The neptunium-237 transported from SRS to ORNL would be stored at REDC. The plutonium-238 product would be transported from ORNL to LANL for use in radioisotope power systems for future U.S. space missions. A new support facility at an existing

DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 2.** FDPF at INEEL would be used to fabricate and process the neptunium-237 targets associated with plutonium-238 production. The neptunium-237 transported from SRS to INEEL would be stored in FDPF or Building CPP–651 at INEEL. The plutonium-238 product would be transported from INEEL to LANL for use in radioisotope power systems for future U.S. space missions. A new support facility at an existing DOE site would be used to fabricate and process the targets required to produce medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 3.** FMEF at Hanford would be used to fabricate and process the neptunium-237 targets for plutonium-238 production. The neptunium-237 transported from SRS to Hanford would be stored in FMEF. The plutonium-238 product would be transported from Hanford to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

2.5.5 Alternative 4—Construct New Research Reactor

Under Alternative 4, a new research reactor would be used for target irradiation for the evaluation period of 35 years. The new research reactor, to be constructed at an existing DOE site, would be used to irradiate all targets (i.e., for the production of plutonium-238, isotopes for medical and industrial uses, and materials testing for civilian nuclear energy research and development). Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue.

The targets for plutonium-238 production would be fabricated in one of the three candidate facilities at ORNL, INEEL, or Hanford. The material needed for the target fabrication (neptunium-237) would be transported from SRS to the fabrication facilities. The targets would be irradiated at the new research reactor facility and transported back to the target fabrication facilities for postirradiation processing.

Targets for medical and industrial isotope production would be fabricated in a new support facility located at the same site as the new research reactor. The targets would be irradiated in the new research reactor and returned to the new support facility for postirradiation processing.

Alternative 4 site selection is not evaluated as part of this NI PEIS. Because Alternative 4 is evaluated at a generic DOE site, no credit was taken for any existing support infrastructure existing at the site and it was postulated that a new support facility would be required to support operation of the new research reactor and its missions. While this approach bounds this NI PEIS for the implementation of Alternative 4, it overstates the impacts because this NI PEIS integrates the impacts associated with constructing new support facilities and infrastructure that may be available at the existing DOE site. In the event that Alternative 4 were selected by the Record of Decision for subsequent consideration, follow-up NEPA reviews would evaluate potential locations for the new research reactor. It is unlikely that DOE would consider locating the new research reactor on a DOE site that does not have existing infrastructure capable of supporting all or most of the proposed medical and industrial isotope production and nuclear research and development mission requirements.

Under Alternative 4, nonirradiated targets, irradiated targets, and processed materials would be transported between the locations selected for storage, target fabrication, target irradiation, postirradiation processing, and the final destination of the plutonium-238. Alternative 4 also would include the decontamination and

decommissioning of both the research reactor and the support facility when the missions are completed, as well as deactivation of FFTF at Hanford.

The proposed new research reactor would provide ample neutrons for the production of plutonium-238 and for many of the isotopes listed in Table 1–1. The thermal flux would limit the new research reactor's ability to produce a number of isotopes requiring fast or high-energy neutrons. Its lower flux levels (10^{13} neutrons per square centimeter per second) and predominantly thermal flux may limit its ability to support many of the projected nuclear-based research and development needs.

The three options under this alternative and their associated target fabrication, postirradiation processing, and transportation activities are discussed below.

- **Option 1.** REDC at ORNL would be used to fabricate and process the neptunium-237 targets associated with plutonium-238 production. The neptunium-237 transported from SRS to ORNL would be stored at REDC. The plutonium-238 product would be transported from ORNL to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required to produce medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 2.** FDPF at INEEL would be used to fabricate and process the neptunium-237 targets associated with plutonium-238 production. The neptunium-237 transported from SRS to INEEL would be stored in FDPF or Building CPP–651. The plutonium-238 product would be transported from INEEL to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required to produce medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 3.** FMEF at Hanford would be used to fabricate and process neptunium-237 targets for plutonium-238 production. The neptunium-237 transported from SRS to Hanford would be stored in FMEF. The plutonium-238 product would be transported from Hanford to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

2.5.6 Alternative 5—Permanently Deactivate FFTF (with No New Missions)

Under Alternative 5, DOE would permanently deactivate FFTF, with no new missions. Medical and industrial isotope production and civilian nuclear energy research and development missions, at the existing facilities described in Chapter 3, would continue. DOE's nuclear facilities infrastructure would not be enhanced.

2.6 Alternatives Considered and Dismissed

In developing a range of reasonable alternatives, DOE examined the capabilities and available capacities of the existing and planned nuclear research facilities (accelerators, reactors, and processing [hot] cells) that potentially could be used to support one or all of the proposed isotope production and research missions (DOE 2000a). The following facilities were initially considered, but were subsequently dismissed as reasonable alternatives for meeting DOE's proposed nuclear infrastructure mission requirements.

2.6.1 Irradiation Facilities Dismissed

DOE evaluated the irradiation capabilities of existing government, university, and commercial irradiation facilities to determine whether they could significantly support the proposed expanded nuclear infrastructure missions. **Table 2–4** presents irradiation facilities that were initially considered but dismissed from further evaluation because they lacked technical capability or available capacity. Reasons for lacking technical capability include that the facility has been permanently shut down, it does not possess the capability to produce steady-state neutrons, or that it could not maintain sufficient power levels to adequately support steady-state neutron production. Facilities were similarly dismissed if existing capacity was fully dedicated to existing missions, or if use of existing capacity to support this NI PEIS proposed action would impact existing missions. Although a number of facilities shown in Table 2–4 have some available capacity, their combined available capacity is a very small percentage of the capacity needed to support the missions evaluated in this NI PEIS.

Two of these facilities, the Brookhaven LINAC Isotope Producer (BLIP) at the Brookhaven National Laboratory and the Isotope Production Facility (IPF) at the Los Alamos Neutron Science Center (LANSCE), were identified in the NI PEIS Notice of Intent as existing facilities that could potentially support the proposed nuclear infrastructure missions. IPF produces radioisotopes using LANSCE's half-mile accelerator that delivers medium-energy protons. IPF's three major products include germanium-68, strontium-82, and sodium-22. As a result of changing DOE missions, the production of radioisotopes at target area "A" of the LANSCE has been rendered inoperable. DOE is currently in the process of upgrading the LANSCE facility with a new 100-million-electron-volt IPF. The facility is scheduled for completion in 2001. After completion of the LANSCE upgrade, the existing capability at these two facilities will be twice the current need for accelerator-generated medical isotopes. Thus, no new accelerator capacity is needed in the short term. Should isotope demand grow consistent with the Expert Panel Report, there will be a need for expanded isotope production capacity for those isotopes generated by IPF and BLIP. IPF and BLIP were dismissed as reasonable alternatives for the production of medical isotopes because they cannot meet the projected future demand for accelerator-produced isotopes.

The Alternating Gradient System (AGS) accelerator complex at the Brookhaven National Laboratory was evaluated for meeting the mission requirements of medical and industrial isotope production, plutonium-238 production, and civilian nuclear energy research and development. AGS presently accelerates up to 7×10^{13} protons to 24 gigaelectron volts with a cycle time of approximately 2.5 seconds. This corresponds to a beam power of approximately 100 kilowatts. The complex was dismissed as a reasonable alternative because the potential neutron flux generated by the facility in the required configuration (i.e., with a spallation target) would not be adequate to meet the mission goals and, in addition, operating the complex in the required configuration would not be compatible with the present primary mission of the facility (Kovar 2000).

Two existing operating DOE facilities, ATR and HFIR, were evaluated as components of Alternative 2, Use Only Existing Operational Facilities. These two facilities currently provide isotope production capabilities and were examined for their abilities to meet the isotope production and nuclear research and development requirements of the proposed expanded missions. In addition, DOE considered whether production from ATR and HFIR could be enhanced by increasing power levels at the reactors or through other modifications to the facilities, which included the installation of rapid radioisotope retrieval systems for the production of isotopes with a short half-life. In general, the installation of rapid radioisotope retrieval systems in reactors does not increase the ability of reactors to produce larger quantities of isotopes; it enables the reactors to produce a broader spectrum of isotopes. While some growth is possible in isotope production at ATR and HFIR, such growth would be insufficient to meet the long-term growth projections discussed in Section 1.2.1. Further growth could only be enabled by increasing reactor power levels. At ATR, increases in power level are possible to the extent that priority DOE Office of Naval Reactor missions are not impacted. Raising ATR

Table 2–4 Irradiation Facilities Considered but Dismissed from Further Evaluation

Reasons for Dismissal	Facility
Facilities lacking sufficient neutron production capacity to support the NI PEIS proposed action without impacting existing missions	Neutron Radiographic Reactor Argonne National Laboratory–West
	Brookhaven Medical Research Reactor Brookhaven National Laboratory
	National Bureau of Standards Reactor National Institute of Standards and Technology
	General Atomics Training, Research, and Isotope Production Reactors
	University Small Research Reactors
	University Large Research Reactors (i.e., Massachusetts Institute of Technology and University of Missouri)
	ATLAS Heavy Ion Facility Argonne National Laboratory
	Oak Ridge Electron Linear Accelerator Oak Ridge National Laboratory
	Holifield Radioactive Ion Beam Facility Oak Ridge National Laboratory
	Heavy Ion Linear Accelerator Lawrence Berkeley National Laboratory
	Alternating Gradient Synchrotron Heavy Ion Facility Brookhaven National Laboratory
	Continuous Electron Beam Accelerator Facility Thomas Jefferson National Accelerator Facility
	Electron Linear Accelerator Lawrence Livermore National Laboratory
	University Linear Accelerators
Facilities with capacity fully dedicated to existing missions	Annular Core Research Reactor Sandia National Laboratory
	Brookhaven LINAC Isotope Producer Brookhaven National Laboratory
Facilities not capable of steady-state neutron production	Sandia Pulse Reactor II and III Sandia National Laboratory
	Transient Reactor Test Facility Argonne National Laboratory–West
	Zero Power Physics Reactor Idaho National Engineering and Environmental Laboratory
	Power Burst Facility Idaho National Engineering and Environmental Laboratory
	Intense Pulsed Neutron Source Argonne National Laboratory
	Flash X-Ray Facility Lawrence Livermore National Laboratory

Table 2–4 Irradiation Facilities Considered but Dismissed from Further Evaluation (Continued)

Reason for Dismissal	Facility
Facilities with insufficient power to sustain adequate steady-state neutron production	Brookhaven Medical Research Reactor Brookhaven National Laboratory
	Los Alamos Critical Assembly Facility Los Alamos National Laboratory
	General Atomics Training, Research, and Isotope Production Reactors
	University Small Research Reactors
	Booster Applications Facility Brookhaven National Laboratory
	Cyclotron Facility Brookhaven National Laboratory
	Low-Energy Demonstration Accelerator[a] Los Alamos National Laboratory
Facilities that jointly can meet existing accelerator-produced medical isotope demands but cannot meet projected future needs	Los Alamos Neutron Science Center Linear Accelerator Isotope Production Facility Los Alamos National Laboratory
	Brookhaven LINAC Isotope Producer Brookhaven National Laboratory
Facilities that are under construction with capacity fully dedicated to other planned missions	Dual Axis Radiographic Hydrodynamic Test Facility Los Alamos National Laboratory
	Spallation Neutron Source Oak Ridge National Laboratory
Facilities that have been permanently shut down	High Flux Beam Reactor Brookhaven National Laboratory
	Tower Shielding Facility Oak Ridge National Laboratory
	Cyclotron Facility Oak Ridge National Laboratory

a. Not listed in source document.
Key: LINAC, linear accelerator; ATLAS, Argonne Tandem - LINAC Accelerator System.
Source: DOE 2000a.

power would only delay the point in time at which capacity is reached. The power level at HFIR is already at 100 percent of its current Authorization Basis (85 megawatts), and modification of this Authorization Basis would be required to increase to full-design power (100 megawatts). Increasing the power levels at ATR and/or HFIR will enhance the isotope production capability of these reactors. However, the enhancement in production capability would not be adequate to meet the future demand for isotope production; it would only delay the point in time at which the United States' reactor isotope production capacity is reached. Therefore, increasing the power levels at ATR and/or HFIR was dismissed as a reasonable alternative for meeting the requirements of the DOE missions.

Modification of CLWRs to enable online insertion and retrieval of targets for the medical and industrial isotope production missions was evaluated and dismissed as a reasonable alternative. This decision was made because the required facility modifications would be significant and would include penetrations into the reactor vessel and, potentially, the containment vessel. Additional facility modifications would be required to enable loading of the targets into a shielded cask for transport to a processing facility. Performing these facility modifications would require an extended refueling outage (with a resulting loss of power generation revenue to the CLWR owner) and could potentially extend subsequent maintenance or refueling outages to inspect, test, and maintain the insertion and retrieval system, reactor vessel penetrations, and potential containment vessel penetrations. CLWRs were considered for the production of medical isotopes with moderate and long half-lives by

irradiating targets in the CLWR vessel but outside the reactor core region (i.e., outside of the fuel assembly region). Only one of the isotopes listed in the Expert Panel Report, *Expert Panel: Forecast Future Demand for Medical Isotopes* (Wagner et al. 1998), strontium-89, was considered a potential candidate for production in a CLWR, outside of the reactor core region. Strontium-89 has a half-life of 50.5 days. Irradiated targets containing strontium-89 could only be harvested from a CLWR every 18 to 24 months during a scheduled reactor refueling outage. Approximately 10 CLWRs with refueling outages scheduled every 2 to 3 months would be required to support a program to ensure a continuous and reliable supply of strontium-89. Due to the CLWR's ability to irradiate targets for only a very limited array of medical isotopes (only one isotope in current demand was identified), it was not considered a reasonable alternative for expanding the U.S. infrastructure to provide an overall enhancement of the medical isotope production missions. CLWRs were also considered for the proposed DOE civilian nuclear energy research and development missions. CLWRs will continue to support the commercial industry research and development activities by providing a test bed for industry-sponsored lead test assemblies and other related research. CLWRs cannot meet most of the requirements for supporting the DOE civilian nuclear energy research and development missions and, therefore, were dismissed as a reasonable alternative for supporting these missions.

CANDU reactors, operating in Canada, were considered for supplying irradiation services for the plutonium-238 production mission. (Note: Canada is currently the major supplier of medical radioisotopes used in the United States.) Since use of the CANDU reactors does not meet the programmatic issue being addressed in this NI PEIS, that is, the enhancement of the United States infrastructure to support the proposed missions, the CANDU reactors were considered but were dismissed as a reasonable alternative. However, the environmental impacts associated with transporting the nonirradiated and irradiated neptunium-237 targets between the CANDU reactors and the target fabrication and processing facilities in the United States are bound by the evaluations presented in this NI PEIS for the CLWR options of Alternative 2 (Use Only Existing Operational Facilities).

Some facilities listed in Table 2–4 do not have the capacity to support the proposed missions without impacting existing missions, but do have some existing medical or industrial isotope production or nuclear research and development missions. These facilities will continue to support their existing missions at current levels.

2.6.2 Processing Facilities Dismissed

Numerous existing U.S. processing hot cell facilities possess the capabilities and capacities to support the proposed missions. Given this general availability, only existing processing facilities that are colocated at DOE's candidate irradiation facility sites (i.e., ORNL, INEEL, and Hanford) were evaluated in this NI PEIS. Although multiple processing facilities exist at each of these sites, only the most suitable facilities in terms of capability, capacity, and availability were given further consideration. The processing facilities that were dismissed from evaluation are listed in **Table 2–5**.

Based on public comments on the scope of the proposed *Plutonium-238 Production EIS,* the H-Canyon and HB-Line facilities at SRS that previously performed the processing for the plutonium-238 production mission were reconsidered as potential processing facilities for the proposed plutonium-238 production mission even though the facilities are not colocated with a proposed irradiation facility. After reviewing the plutonium-238 production target fabrication and processing requirements, the capabilities and capacities of the facilities, and the modifications and resources required to support the plutonium-238 production mission, use of the H-Canyon and HB-Line facilities was dismissed as a reasonable alternative because:

1. DOE plans to shut down these facilities following completion of their current missions to stabilize and prepare for disposition of Cold War legacy nuclear materials and certain spent nuclear fuel, and a

Table 2–5 Processing Facilities Considered but Dismissed from Further Evaluation

Location	Facility
Argonne National Laboratory	Irradiated Materials Facility
	Alpha-Gamma Hot Cell Facility
	Building 205
Argonne National Laboratory–West	Hot Fuel Examination Facility
	Analytical Laboratory
	Fuel Conditioning Facility
Brookhaven National Laboratory	Target Processing Laboratory
	Metallurgical Evaluation Laboratory
	High Intensity Radiation Development Laboratory
Hanford Site	222-S Facility
	Postirradiation Testing Laboratory
	Shielded Material Facility
Idaho National Engineering and Environmental Laboratory	Test Area North Hot Shop and Hot Cell Facilities
	Remote Analytical Laboratory
	Fuel Processing Facility
Los Alamos National Laboratory	Chemistry and Metallurgical Research Building
	Technical Area–48
Oak Ridge National Laboratory	Radioactive Materials Analytical Laboratory
	Building 4501
	Irradiated Materials Examination and Testing Facility
	Radioisotope Development Laboratory
	Irradiated Fuels Examination Laboratory
Sandia National Laboratories	Hot Cell Facility
Savannah River Site	Defense Waste Processing Facility
	High-level cells
	Intermediate-level cells
	Californium shipping/receiving facility
	Californium processing facility

Source: DOE 2000a.

determination that a new nonchemical processing technology is capable of preparing aluminum-clad research reactor spent nuclear fuel for ultimate disposition.

2. The cost to extend the operating lives of these facilities to support plutonium-238 production for the proposed 35-year evaluation period would be approximately one order of magnitude higher than the costs associated with the processing facilities evaluated in this NI PEIS.

A commentor also proposed using the H-Canyon and HB-Line for a short campaign to produce all of the required plutonium-238. Based on prior production rates, it would take approximately 7 years to produce 175 kilograms (385 pounds) of plutonium-238, the total plutonium-238 production goal. The target fabrication and irradiation requirements to support this processing campaign to produce 25 kilograms (55 pounds) per year of plutonium-238 would be significant but feasible. The irradiation requirements could be supported by operating five CLWRs or operating FFTF at the 400-megawatt power level. However, a concern about the short campaign option is that the plutonium-238 would be stored a long time before use and because of natural decay may not meet the specification requirements when finally needed. This alternative was dismissed

because of the uncertainty that over time the plutonium-238 produced may not meet the required specification for NASA missions.

2.7 SUMMARY OF ENVIRONMENTAL IMPACTS, SCHEDULES, AND MISSION EFFECTIVENESS

The following sections summarize the environmental impacts and schedules associated with the alternatives and options and compare the impacts among the alternatives described in Sections 4.2 through 4.7. Chapter 4 shows construction impacts that would result from implementation of Alternative 3 and 4, as well as operational impacts for all of the alternatives. Section 2.7.1 compares the environmental impacts and risks among the alternatives. Section 2.7.2 summarizes the implementation schedules for each alternative. Mission effectiveness is discussed in Section 2.7.3.

As discussed in Section 1.8, tables and text in this section have been revised in response to comments about the difficulty of comparing environmental impacts among the alternatives in the Draft NI PEIS. Tables and figures in this section now focus on estimated environmental impacts that would result from implementation of the alternatives. Baseline environmental data for the sites and for the candidate facilities are now given in Chapter 3. In this NI PEIS, Option 1 of the No Action Alternative is used as a basis for the comparison of impacts at candidate sites.

Numerical values are assigned to environmental impacts that include radiological and nonradiological risks to the public and workers at the candidate sites and along representative transportation routes, potential quantities of waste generated, and potential quantities of spent nuclear fuel generated. These numerical values reflect the degree to which the proposed activities would increase the environmental impacts of current activities and operations at the candidate sites. It should be noted that most of the options being considered under the various alternatives involve the use of more than one site, so the numerical values presented are the sums of the values for all of the relevant sites or transportation routes. There are two exceptions—the health risks to the maximally exposed individual and the noninvolved worker. For these two exceptions, the numerical value presented is the maximum value among all relevant sites.

2.7.1 Summary of Environmental Impacts

2.7.1.1 Radiological and Hazardous Chemical Impacts

RADIOLOGICAL IMPACTS

Table 2–6 summarizes radiological and hazardous chemical risks that could occur under implementation of the alternatives from operations at fabrication, processing, and irradiation facilities. Radiological risks to the maximally exposed individual are listed in columns 2 and 5 for normal operations and accidents, respectively. Similarly, columns 3 and 6 display radiological risks to the public for normal operations and accidents, and columns 4 and 7 show radiological risks to workers at candidate irradiation facilities and processing and fabrication facilities. As indicated in the table, Option 1 of the No Action Alternative is the basis for comparing impacts that would result from implementation of the other alternatives and options. Impact values for Option 1 of the No Action Alternative are set to zero and provide a reference point for comparing impacts that would result from implementation of the other alternatives and options. Negative values in the table indicate a decrease in risk with respect to Option 1 of the No Action Alternative.

The risk values presented are the sum of individual risk values from operational activities in the fabrication, processing, and irradiation facilities used under each alternative and option. For Alternatives 2 through 4, where FFTF would be permanently deactivated, the values presented also include the reduction in risk from

Table 2–6 Comparison Among Alternatives: Impacts on Occupational and Public Health and Safety from Baseline Conditions

Options[a]	Radiological Risks from Normal Operations over 35 Years			Radiological Risks[b] from Accidents over 35 Years			Hazardous Chemical Risks from Normal Operations over 35 Years	
	Maximally Exposed Individual (LCF Risk)	Population (LCF)	Workforce (LCF)	Maximally Exposed Individual (LCF Risk)	Population (LCF)	Workforce (LCF)	Maximum Cancer Risk[c]	Hazard Index[d]
No Action Alternative								
1[e]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	3.0×10^{-12}	1.4×10^{-7}	0.017	0.00	0.00	0.00	0.00	0.00
3	4.2×10^{-13}	6.1×10^{-9}	0.017	0.00	0.00	0.00	0.00	0.00
4	7.0×10^{-13}	7.5×10^{-8}	0.017	0.00	0.00	0.00	0.00	0.00
Alternative 1: Restart FFTF								
1 or 4	9.3×10^{-8}	0.0039	0.25	4.5×10^{-4}	0.54	3.5×10^{-4}	2.6×10^{-7}	0.0064
2 or 5	9.3×10^{-8}	0.0039	0.25	4.5×10^{-4}	0.41	3.5×10^{-4}	1.3×10^{-7}	0.0031
3 or 6	9.6×10^{-9}	0.0018	0.25	6.8×10^{-6}	0.21	4.2×10^{-4}	4.7×10^{-8}	0.0011
Alternative 2: Use Only Existing Operational Facilities[f, g]								
1	3.3×10^{-11}	-4.7×10^{-4}	0.16	5.7×10^{-5}	0.16	3.5×10^{-4}	2.6×10^{-7}	0.0064
2	4.6×10^{-12}	-4.7×10^{-4}	0.16	1.5×10^{-5}	0.03	3.5×10^{-4}	1.3×10^{-7}	0.0031
3	-2.3×10^{-9}	-4.7×10^{-4}	0.16	2.9×10^{-6}	0.11	3.5×10^{-4}	4.7×10^{-8}	0.0011
4	3.3×10^{-11}	-4.7×10^{-4}	0.16	5.7×10^{-5}	0.16	3.5×10^{-4}	2.6×10^{-7}	0.0064
5	4.6×10^{-12}	-4.7×10^{-4}	0.16	1.5×10^{-5}	0.03	3.5×10^{-4}	1.3×10^{-7}	0.0031
6	-2.3×10^{-9}	-4.7×10^{-4}	0.16	2.9×10^{-6}	0.12	3.5×10^{-4}	4.7×10^{-8}	0.0011
7	3.3×10^{-11}	-4.7×10^{-4}	0.16	5.7×10^{-5}	0.16	3.5×10^{-4}	2.6×10^{-7}	0.0064
8	4.6×10^{-12}	-4.7×10^{-4}	0.16	1.5×10^{-5}	0.03	3.5×10^{-4}	1.3×10^{-7}	0.0031
9	-2.3×10^{-9}	-4.7×10^{-4}	0.16	2.9×10^{-6}	0.11	3.5×10^{-4}	4.7×10^{-8}	0.0011
Alternative 3: Construct New Accelerator(s)[f, g]								
1	6.1×10^{-8}	0.0030	0.95	9.2×10^{-5}	0.22	5.0×10^{-4}	1.6×10^{-9}	1.1×10^{-7}
2	6.1×10^{-8}	0.0030	0.95	5.0×10^{-5}	0.09	5.0×10^{-4}	1.6×10^{-9}	1.1×10^{-7}
3	6.1×10^{-8}	0.0030	0.95	3.8×10^{-5}	0.18	5.0×10^{-4}	1.6×10^{-9}	1.1×10^{-7}
Alternative 4: Construct New Research Reactor[f, g]								
1	4.5×10^{-8}	0.002	0.49	9.0×10^{-5}	0.21	4.5×10^{-4}	6.4×10^{-10}	2.3×10^{-6}
2	4.5×10^{-8}	0.002	0.49	4.8×10^{-5}	0.08	4.5×10^{-4}	6.4×10^{-10}	2.3×10^{-6}
3	4.5×10^{-8}	0.002	0.49	3.6×10^{-5}	0.17	4.5×10^{-4}	6.4×10^{-10}	2.3×10^{-6}
Alternative 5: Permanently Deactivate FFTF (with No New Missions)								
	-2.3×10^{-9}	-4.7×10^{-4}	-0.0097	-2.2×10^{-13}	-1.6×10^{-8}	-1.3×10^{-13}	0.00	0.00

a. For descriptions of the options under each alternative, see Section 2.5.
b. Accident risks include accident likelihood over 35 years and the consequences.
c. Probability that an individual would develop cancer from exposure to hazardous (carcinogenic) chemicals.
d. A measure of hazard from exposure to multiple toxic (noncarcinogenic) chemicals. If this value is less than 1, the exposure is unlikely to produce an adverse toxic effect.
e. Baseline conditions for the comparison of impacts is Option 1 of the No Action Alternative.
f. These alternatives include FFTF deactivation impacts. The deactivation would lead to negative impacts (reduced risk); see Alternative 5.
g. The reduction in impacts from deactivating FFTF would affect the impacts to the population and workforce for Alternatives 2 through 4 and to the maximally exposed individual only for those options within Alternatives 2 through 4 that use FMEF.

Note: Refer to the text for a discussion on how the risk values in this table have been generated.
Key: LCF, latent cancer fatalities.

FFTF deactivation, where applicable. For example, the radiological risk to the population from normal operations for Option 3 of Alternative 2 (i.e., irradiation at ATR, fabrication and processing at FMEF, and deactivation of FFTF) is given as -4.7×10^{-4} latent cancer fatality. This value was calculated by adding the population risks from fabrication and processing at FMEF and irradiation at ATR, 7.7×10^{-7} latent cancer fatality (see Table 4–77), and Alternative 5 (Permanently Deactivate FFTF [with No New Missions]), -4.7×10^{-4} latent cancer fatality. The latter risk is the sum of the population risk associated with the activities during permanent deactivation of FFTF, 1.8×10^{-5} latent cancer fatality (see Section 4.4.1.2), and that resulting from not keeping FFTF in standby for 35 years, -4.9×10^{-4} latent cancer fatality (the negative value reflects the reduction in risk) (see Section 4.2.1). The radiological risks for accident conditions are the sum of accident risks evaluated for each option. For each accident, the risk value is the product of the accident consequences and its occurrence likelihood over 35 years of operation. Chapter 4, Appendix H, and Appendix I provide the details on public and occupational risk calculations.

A comparison of radiological risks estimated to result from normal operations over 35 years (columns 2 and 3 of Table 2–6) shows that implementation of the alternatives would result in a small risk of a latent cancer fatality among the general public. Radiological accident risks to the public over 35 years (columns 5 and 6 of Table 2–6) are estimated to be less than one latent cancer fatality. **Figure 2–23** shows estimated latent cancer fatalities among the population at risk from potential accidents at candidate sites. Each bar in Figure 2–23 represents the estimated latent cancer fatalities for a given option.

For example, there are six bars shown above the alternative labeled "Restart FFTF." The first of the six bars represents the estimated latent cancer fatalities for implementation of Option 1, the second bar represents the estimated latent cancer fatalities for implementation of Option 2, etc. As discussed in Section 4.2, storage containers for neptunium-237 targets would not be expected to rupture under the most severe accident evaluated in this NI PEIS. Therefore, no latent cancer fatalities would be expected under implementation of the No Action Alternative. Deactivation of FFTF (with no new missions) would result in a small reduction in radiological accident risks in comparison with the No Action Alternative. Differences in the radiological accident risks among alternatives and among options within a given alternative are driven by accident risks at the target fabrication and processing facilities. This point is illustrated in **Figure 2–24**.

Figure 2–24 shows risks to the public that would result from radiological accidents at candidate fabrication and processing facilities and candidate irradiation facilities. Latent cancer fatalities estimated for candidate fabrication and processing facilities are shown to the left of the dividing line in Figure 2–24, and the estimated latent cancer fatalities for candidate irradiation facilities appear on the right side of the dividing line. The estimated latent cancer fatalities for FMEF under Options 3 and 6 of Alternative 1 are labeled "FMEF (Hanford)." Under Options 3 and 6 of Alternative 1, FMEF would serve as the fabrication and processing facility for all targets. If FMEF were selected to fabricate and process neptunium-237 targets only, the radiological risk to the public would be reduced by approximately a factor of two, as shown by the bar labeled "FMEF (Hanford, neptunium-237 targets only)" in Figure 2–24. Among the candidate fabrication and processing facilities, accident risks to the public range from a low of 0.029 latent cancer fatality at FDPF (INEEL) to 0.377 latent cancer fatality at RPL (Hanford). Although all of the accident risks shown in Figure 2–24 are less than one latent cancer fatality, risks to the public that would be expected from radiological accidents at candidate fabrication and processing facilities are relatively large in comparison to those for candidate irradiation facilities.

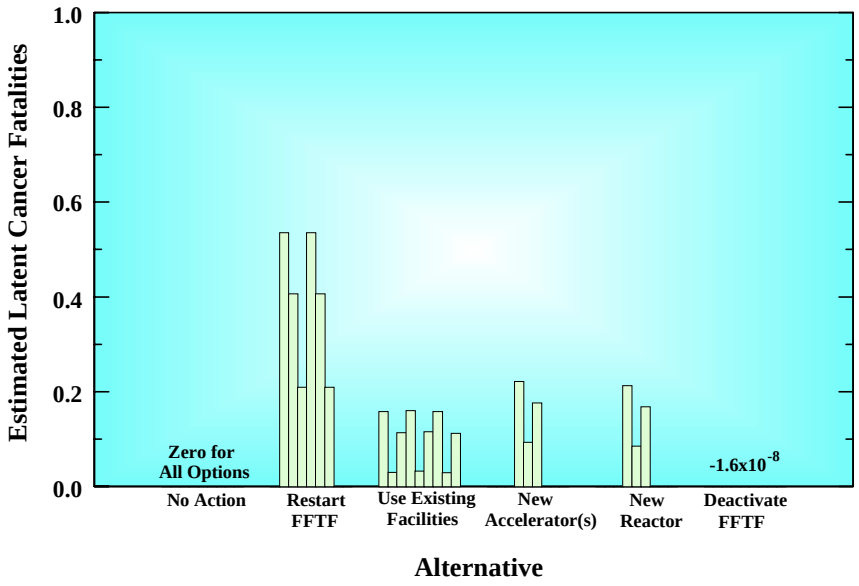

Figure 2–23 Public Risks Due to Radiological Accidents at Candidate Sites (35 Years)

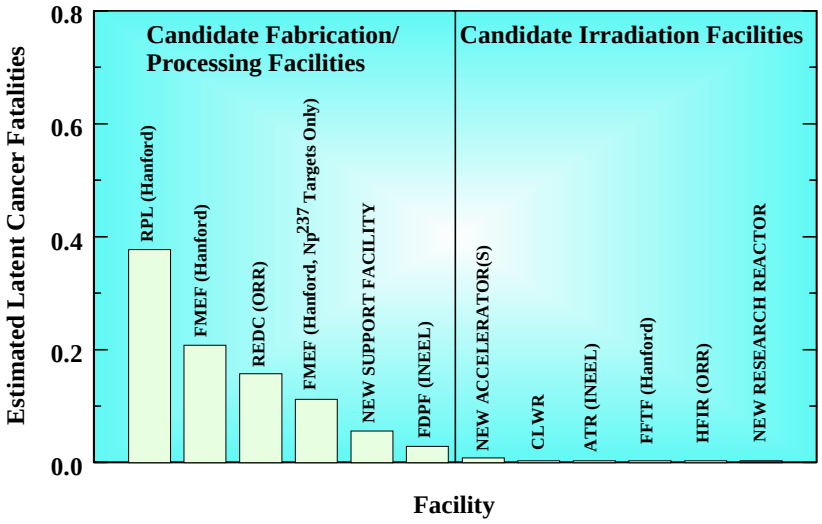

Figure 2–24 Public Risks Due to Radiological Accidents at Candidate Facilities (35 Years)

Prevailing weather conditions, the geographical distribution of the population at risk, and the type of target(s) processed (neptunium-237 only, other isotopes only, or both) all contribute to variations in the radiological risk to the public. Calculations of accident consequences and risks include populations residing within 80 kilometers (50 miles) of the accident site, although the consequences and risks decrease noticeably with increasing distance from the accident site. As shown in **Figure 2–25**, RPL (Hanford) and REDC (ORR) have the largest populations residing within 16 kilometers (10 miles) of candidate sites, while FDPF (INEEL) has the smallest. Because the total population residing within 16 kilometers (10 miles) of FDPF is relatively small, the curve representing populations residing near FDPF is nearly coincident with the horizontal axis in Figure 2–25. Comparing Figures 2–24 and 2–25, it is clear that accident risks due to fabrication and processing activities are driven by both the type of processing activities and the total population residing near the facilities. In turn, variations in accident risks among the alternatives, as well as variations among options within an alternative, are driven by the selection of fabrication and processing facilities. The choice for irradiation facility would have little effect on radiological accident risks to the public.

HAZARDOUS CHEMICAL IMPACTS

Columns 8 and 9 of Table 2–6 display cancer risks and hazard indexes that could result from airborne emissions of hazardous chemicals from candidate processing facilities. As discussed in Section H.3, cancer risk factors listed in column 8 of Table 2–6 are estimates of an upper-bound lifetime probability of an individual developing cancer due to exposure to carcinogenic chemicals. For all alternatives and options, the maximum cancer risk factor is 2.6×10^{-7} (or a likelihood of approximately 1 in 3,800,000) or less. Different carcinogens can cause or promote different forms of cancer. In general, cancer risk factors for different carcinogens are not additive because there are potential synergistic or antagonistic chemical interactions in multiple-substance exposures (EPA 1989). Therefore, column 8 of the table lists the maximum cancer risk factor for each alternative. Hazard indexes listed in column 9 of Table 2–6 estimate the potential for adverse toxic (noncancerous) health effects due to exposure to hazardous chemicals. If the hazard index is less than one, adverse (noncancerous) health effects would not be expected. For all of the alternatives and options, hazard indexes are 0.0064 or less. The results (presented in columns 8 and 9 of Table 2–6) indicate that no adverse toxic health or cancer effects would be expected from exposure to hazardous chemicals released under the implementation of any of the alternatives.

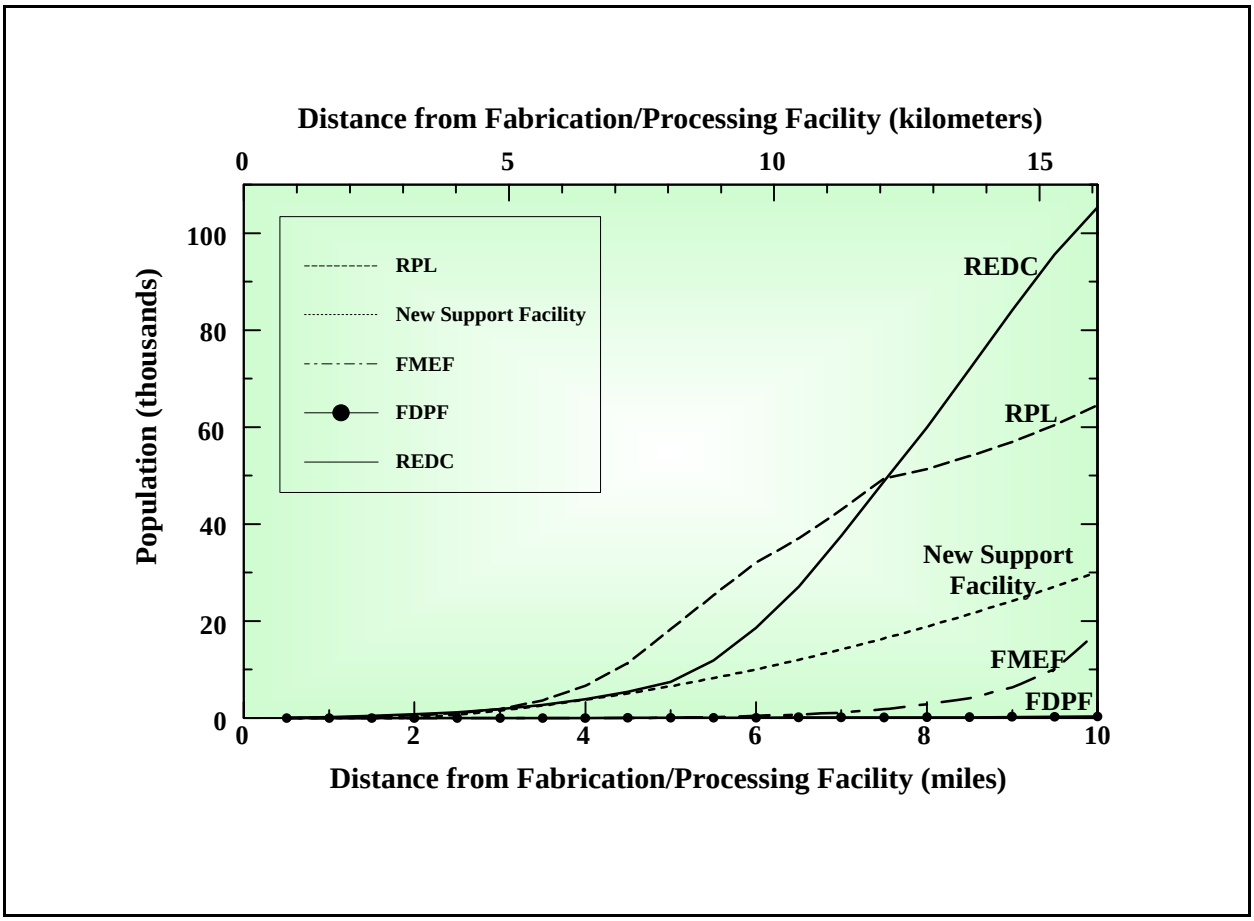

Figure 2–25 Population Residing Within 16 Kilometers (10 Miles) of Candidate Fabrication and Processing Facilities

2.7.1.2 Generation and Disposition of Waste and Spent Nuclear Fuel

Table 2–7 summarizes the estimated amount of waste and spent nuclear fuel that would be generated under implementation of the nuclear infrastructure alternatives. As discussed in Chapter 4, waste that would result from implementation of the alternatives would be relatively small in comparison to current waste generation at the candidate sites. Current waste management practices at the candidate sites would be sufficient to manage waste that would result from the nuclear infrastructure alternatives.

TRANSURANIC WASTE/HIGH-LEVEL RADIOACTIVE WASTE

The analysis for the Draft NI PEIS assumed that the waste generated from the processing of irradiated neptunium-237 targets is transuranic waste. However, as a result of comments received during the public comment period, DOE is considering whether the waste from processing of irradiated neptunium-237 targets should be classified as high-level radioactive waste. Irrespective of how the waste is classified (i.e., transuranic or high-level radioactive), the waste composition and characteristics are the same, and the waste management (i.e., treatment and onsite storage) as described in this NI PEIS would be the same. In addition, either waste type would require disposal in a suitable repository. As shown in column 2 of Table 2–7, between 240 and 380 cubic meters (314 and 497 cubic yards) of transuranic waste or high-level radioactive waste would result from implementation of Alternatives 1 through 4. This waste would result from processing irradiated neptunium-237 targets to harvest plutonium-238. Approximately 380 cubic meters (497 cubic yards) of waste per year for 35 years (see Table 2–7) would be generated for all options under Alternatives 1 through 4, except those for which target fabrication and processing would be conducted at FDPF at INEEL. If FDPF were selected for neptunium target fabrication and processing, then approximately 240 cubic meters (314 cubic yards) of waste would be generated during the program.

LOW-LEVEL AND MIXED LOW-LEVEL WASTE

Columns 3 and 4 of Table 2–7 summarize the total low-level radioactive waste and mixed low-level radioactive waste generation that would be expected from implementation of the alternatives. Low-level radioactive waste would be generated at the irradiation facilities and at the fabrication and processing facilities. As shown, the low-level radioactive waste generation that would result under Alternative 2 would be less than half of that for Alternatives 1, 3, and 4, and mixed low-level radioactive waste generation would be almost half. This is because under Alternative 2 currently operational facilities would be used for target irradiation and these facilities would generate little additional low-level and mixed low-level radioactive waste. Also under Alternative 2, no waste generation would result from production of additional medical and industrial isotopes.

DOE's approach for managing low-level and mixed low-level radioactive waste is provided in the Record of Decision for its Waste Management Program (65 FR 10061). The Record of Decision states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue to the extent practicable, on site at INEEL, LANL, ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal. The Record of Decision does not preclude the use of commercially licensed low-level radioactive waste disposal facilities. Low-level radioactive waste generated at Hanford would be disposed of on site. However, if DOE determines that use of the Hanford waste management infrastructure or other DOE sites is not practical or cost effective, DOE may issue an exemption under DOE Order 435.1 for the use of non-DOE facilities (i.e., commercial facilities) to store, treat, and dispose of such waste generated from the restart and operation of FFTF.

Table 2–7 Comparison of Waste and Spent Nuclear Fuel Generation Among Alternatives

Options[a]	Waste Generation in Cubic Meters (35 Years)					Spent Nuclear Fuel in Metric Tons
	Transuranic/ High-Level	Low-Level	Mixed Low-Level	Hazardous	Nonhazardous	
No Action						
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	<10	0.0	0.0	0.0	0.0
3	0.0	<10	0.0	0.0	0.0	0.0
4	0.0	<10	0.0	0.0	0.0	0.0
Alternative 1: Restart FFTF						
1	380	5,000	320	680	943,000	16
2	240	5,200	320	680	902,000	16
3	380	5,000	320	670	1.5×10^6	16
4	380	5,000	320	680	943,000	16
5	240	5,200	320	680	902,000	16
6	380	5,000	320	670	1.5×10^6	16
Alternative 2: Use Only Existing Operational Facilities						
1	380	2,100	<180[b]	3,100[c]	105,000	0
2	240	2,300	<180[b]	3,100[c]	64,000	0
3	380	2,100	<180[b]	3,100[c]	660,000	0
4	380	2,100	<180[b]	3,100[c]	105,000	0
5	240	2,300	<180[b]	3,100[c]	64,000	0
6	380	2,100	<180[b]	3,100[c]	660,000	0
7	380	2,100	<180[b]	3,100[c]	105,000	0
8	240	2,300	<180[b]	3,100[c]	64,000	0
9	380	2,100	<180[b]	3,100[c]	660,000	0
Alternative 3: Construct New Accelerator(s)						
1	380	5,000	430[b]	3,200[c]	1.1×10^7	NA
2	240	5,200	430[b]	3,200[c]	1.1×10^7	NA
3	380	5,000	430[b]	3,200[c]	1.1×10^7	NA
Alternative 4: Construct New Research Reactor						
1	380	4,800	330[b]	3,300[c]	1.1×10^6	11
2	240	4,900	330[b]	3,300[c]	1.0×10^6	11
3	380	4,800	330[b]	3,300[c]	1.7×10^6	11
Alternative 5: Permanently Deactivate FFTF (with No New Missions)						
	0.0	0.0	(b)	2,500[d]	0.0	0

a. For descriptions of the options under each alternative, see Section 2.5.
b. The deactivation of FFTF would result in the removal of approximately 980,000 liters (260,000 gallons) of sodium. This sodium would be evaluated for alternate uses and is therefore not included in mixed low-level radioactive waste for Alternatives 2 through 5.
c. 2,500 cubic meters of these materials would be evaluated for radioactive contamination and would be reused or recycled if possible.
d. These materials would be evaluated for radioactive contamination and would be reused or recycled if possible.

Key: NA, not applicable.

Solid low-level radioactive waste generated at ORR eventually would have to be disposed of off site due to lack of low-level waste disposal capacity at ORR. Low-level radioactive waste generated at INEEL would be disposed of on site. At some future time, low-level radioactive waste would be disposed of off site.

In compliance with the Waste Management Program Record of Decision, DOE's mixed low-level radioactive waste will be treated at: Hanford, INEEL, ORR, and SRS, and disposed of at Hanford and the Nevada Test Site. Existing candidate sites analyzed in this NI PEIS all have treatment facilities for mixed low-level radioactive waste (see Section 3.2.11 [ORR], Section 3.3.11 [INEEL], and Section 3.4.11 [Hanford]). Solid mixed low-level radioactive waste generated at ORR and INEEL would have to eventually be disposed of off site due to lack of onsite mixed low-level radioactive waste disposal capacity.

HAZARDOUS WASTE

Hazardous waste that would result from implementation of the nuclear infrastructure alternatives is shown in column 5 of Table 2–7. The amount of hazardous waste generated under the alternatives is relatively small in comparison to hazardous waste currently generated at the candidate sites: ORR (Table 3–11), INEEL (Table 3–25), and Hanford (Table 3–34). Estimated amounts of hazardous waste that would be generated under Alternatives 2 through 4 include the hazardous waste that would be generated under Alternative 5 (Permanently Deactivate FFTF [with No New Missions]).

Based on the Record of Decision for hazardous waste issued on August 5, 1998 (63 FR 41810), nonwastewater hazardous waste would be treated and disposed of at offsite commercial facilities. As discussed in Chapter 4, hazardous waste generated under the nuclear infrastructure alternatives would be stored in onsite facilities permitted under the Resource Conservation and Recovery Act or generator accumulation areas prior to shipment to a commercial facility permitted to manage hazardous waste.

NONHAZARDOUS WASTE

Nonhazardous waste that would be expected from implementation of the nuclear infrastructure alternatives is listed in column 6 of Table 2–7. Nonhazardous waste that would be expected under implementation of Alternative 3 (Construct New Accelerator[s]) is at least a factor of six larger than the nonhazardous waste estimated for the other alternatives. As indicated in Sections 4.5.1.1.12 and 4.5.1.2.13, nonhazardous waste that would be produced under Alternative 3 would be driven by sanitary waste and process wastewater resulting from construction and operation of accelerators and the new support facility.

As indicated in Sections 4.3.1.1.13 and 4.3.2.1.13, nonhazardous solid waste that would be generated at ORR and INEEL would represent less than 0.5 percent of the generating site's onsite nonhazardous waste disposal capacity. Nonhazardous solid waste that would be generated at Hanford under the nuclear infrastructure alternatives would be recycled or sent off site for disposal as industrial waste. Nonhazardous process wastewater at the candidate sites would represent a small fraction of the generating sites capacity and would be treated on site. Sanitary wastewater would be treated on site as necessary prior to offsite disposition.

SPENT NUCLEAR FUEL

Changes in the generation of spent nuclear fuel would occur only under implementation of Alternatives 1 (Restart FFTF) and 4 (Construct New Research Reactor). Spent nuclear fuel that would be generated under Alternative 1 would be less than 1 percent (by weight) of the current spent nuclear fuel inventory at Hanford. As discussed in Section 4.3.1.1.14, spent nuclear fuel that would be generated at Hanford under implementation of Alternative 1 would be placed in facility storage vessels and onsite dry storage pending ultimate disposal in a geologic repository. Spent nuclear fuel generated under Alternative 4 would be stored on site in wet storage pending ultimate disposal in a geologic repository (Section 4.6.1.2.14).

2.7.1.3 Water Use

CONSTRUCTION

For construction of new facilities under Alternatives 3 (Construct New Accelerator[s]) and 4 (Construct New Research Reactor), water is expected to be required for such uses as mixing concrete, dust control, washing activities, and potable and sanitary needs. Water use for facility construction is estimated at 22.7 million liters (6 million gallons) for the high-energy accelerator, 14 million liters (3.7 million gallons) for the low-energy accelerator, 11.7 million liters (3.1 million gallons) for the new research reactor, and 14.6 million liters (3.85 million gallons) for the new support facility on an annualized (construction-year) basis.

OPERATIONS

Figure 2–26 shows the annual water use that would be expected to occur under the nuclear infrastructure alternatives. As discussed in Section 2.5.1 under the No Action Alternative, FFTF would remain in standby and DOE's nuclear infrastructure would not be enhanced. In standby condition, the FFTF uses approximately 197 million liters (52 million gallons) of groundwater per year. In Figure 2–26, the No Action Alternative is used as a basis for comparison of water use among the alternatives. Therefore, water use for the No Action Alternative is shown as zero. The water use shown in Figure 2–26 for Alternative 1 (Restart FFTF) is the additional groundwater use that would result from operation of the FFTF. Under Alternatives 2 through 5, FFTF would be deactivated, thus saving approximately 197 million liters (52 million gallons) per year in groundwater required for maintaining FFTF in standby. As a result, the water use is negative for Alternatives 2 (Use Only Existing Operational Facilities) and 5 (Permanently Deactivate FFTF [with No New Missions]). The negative increment in water use would be more than offset by the increase in water use estimated for Alternatives 3 (Construct New Accelerator[s]) and 4 (Construct New Research Reactor).

2.7.1.4 Air Quality

CONSTRUCTION

Under Alternatives 3 (Construct New Accelerator[s]) and 4 (Construct New Research Reactor), new irradiation and support facilities would be constructed to support DOE's nuclear missions. Facility construction would not be required under the other alternatives. **Tables 2–8** and **2–9** show the estimated concentrations of air pollutants that would be expected during construction conducted under Alternatives 3 and 4, respectively. Since no specific site has yet been selected for the new accelerator[s] or the new research reactor, Federal standards are used in column 3 of the tables. As discussed in Section 4.5.1.1.3, the effects of constructing the new high-energy accelerator were used to characterize air quality impacts under Alternative 3 (Construct New Accelerator[s]). Construction impacts of the low-energy accelerator and support facilities would add relatively small concentrations to those shown in column 4 of Table 2–8. If Alternative 3 and/or Alternative 4 were selected for implementation, site-specific environmental documentation would be prepared prior to site selection.

The negative increment in water use would be more than offset by the increase in water use estimated for Alternatives 3 (Construct New Accelerator[s]) and 4 (Construct New Research Reactor).

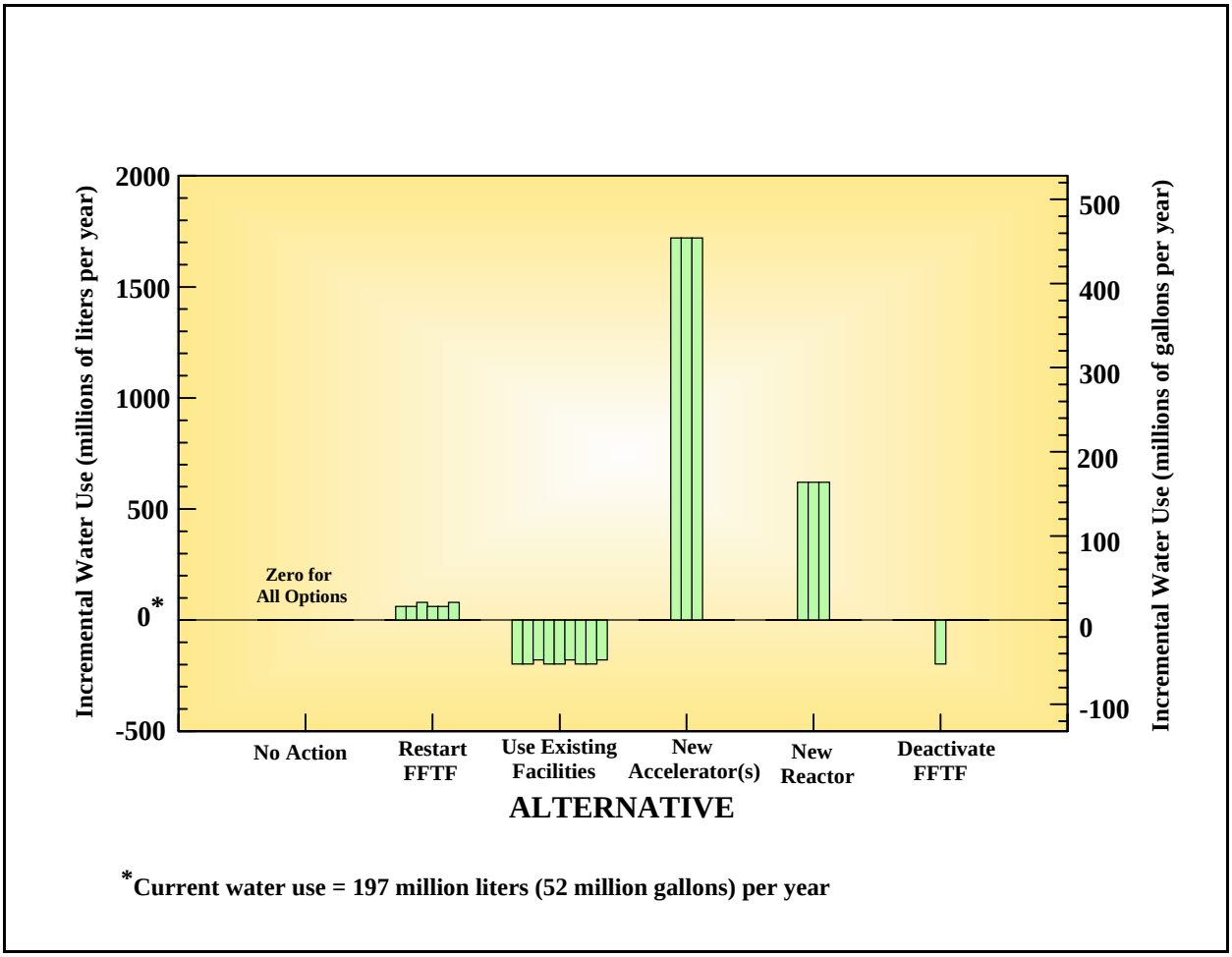

Figure 2–26 Annual Water Use Under the Nuclear Infrastructure Alternatives

Table 2–8 Air Pollutant Concentrations Resulting from Construction of a High-Energy Accelerator Under All Options of Alternative 3

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (microgram per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	436 623
Nitrogen oxide	Annual	100	42
PM_{10}	Annual 24 hours	50 150	3 69
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	3 64 143

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

Source: Modeled increments are based on SCREEN3 computer code (EPA 1995); data from TechSource 2000.

Table 2–9 Air Pollutant Concentrations Resulting from Construction of a New Research Reactor Under All Options of Alternative 4

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (microgram per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	72 103
Nitrogen oxide	Annual	100	1
PM_{10}	Annual 24 hours	50 150	3 88

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standards.

Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995); data from Appendix E. Missions]).

As shown in Tables 2–8 and 2–9, construction of the new irradiation and support facilities would not be expected to exceed Federal standards and guidelines for ambient air quality. However, in comparison with air pollutant concentrations expected from facility operations (discussed in Section 2.7.1.5.2 below), concentrations of air pollutants that would be expected during construction are relatively large. If the new facilities were constructed in an area with existing high background concentrations, construction activities could produce enough air pollutant emissions to exceed ambient air quality standards

OPERATIONS

No Action Alternative

Under the No Action Alternative (Section 2.5.1), FFTF would remain in standby and DOE's nuclear infrastructure would not be enhanced to meet the nuclear infrastructure missions described in Section 1.2. Air quality effects that would be expected from transportation of neptunium-237 oxide to REDC (Option 2), FDPF (Option 3), or FMEF (Option 4) are summarized in Section 2.7.1.6.

Alternatives 1 through 5

Oak Ridge Reservation. Under Alternatives 1 (Options 1 and 4), 2 (Options 1, 4, and 7), 3 (Option 1), and 4 (Option 1), air quality impacts at ORR would result from the production of plutonium-238 at REDC. Concentrations of air pollutants that would be expected from facility operations conducted under these alternatives and options are shown in column 4 of **Table 2–10**. All of the expected concentrations are small in comparison with the most stringent ambient air quality standards shown in column 3 of Table 2–11. Operation of REDC in support of plutonium-238 production would not be expected to significantly affect air quality or to result in air pollutant concentrations in excess of ambient air quality standards. No air quality impacts would result from operation of HFIR under Alternative 2 (Use Only Existing Operational Facilities).

Idaho National Engineering and Environmental Laboratory. Under Alternatives 1 (Options 2 and 5), 2 (Options 2, 5, and 8), 3 (Option 2) and 4 (Option 2), air quality impacts at INEEL would result from the production of plutonium-238 at FDPF. Concentrations of air pollutants that would be expected from facility operations conducted under these alternatives and options are shown in column 4 of **Table 2–11**. All of the expected concentrations are small in comparison with the most stringent ambient air quality standards shown in column 3 of the table. Operation of FDPF in support of plutonium-238 production would not be expected to significantly affect air quality or to result in air pollutant concentrations in excess of ambient air quality

Table 2–10 Air Pollutant Concentrations Expected from Operation of the Radiochemical Engineering Development Center Under Alternatives 1 Through 4

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	100	1.99×10^{-4}
Sulfur dioxide	Annual	80	0.04
	24 hours	365	0.31
	3 hours	1,300	0.70

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995); 40 CFR Part 50.

Table 2–11 Air Pollutant Concentrations Expected from Operation of the Fluorinel Dissolution Process Facility Under Alternatives 1 Through 4

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Criteria pollutants			
Nitrogen dioxide	Annual	100	3.66×10^{-4}
Sulfur dioxide	Annual	80	0.024
	24 hours	365	0.19
	3 hours	1,300	0.43
Toxic air pollutants			
Methanol	24 hours	13,000	0.0048
Nitric acid	24 hours	250	0.0097
Paraffin hydrocarbons	24 hours	100	0.44
Tributyl phosphate	24 hours	110	0.25

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995); 40 CFR Part 50; WDEC 1998.

standards. No air quality impacts would result from operation of ATR under Alternative 2 (Use Only Existing Operational Facilities).

Hanford Site. If Alternative 1 were selected for implementation, impacts on air quality at Hanford would result from operation of FFTF (all options), RPL (Options 1, 2, 4, and 5), and FMEF (Options 3 and 6). FMEF could also be used for production of plutonium-238 under Alternatives 2 (Options 3, 6, and 9), 3 (Option 3), and 4 (Option 3). Concentrations of air pollutants that would be expected from facility operations conducted under these alternatives and options are shown in **Table 2–12**. Numbers in the third row of Table 2–12 are the most stringent state or Federal standard for each averaging period. FFTF would be deactivated under Alternatives 2 through 5. Deactivation would, in turn, result in the shutdown of diesel-driven fire pumps, oil-fired preheaters, and a gas turbine that currently support FFTF's standby condition. If any of Alternatives 2 through 5 were selected for implementation, emissions from this supporting equipment would cease, thereby improving the air quality near FFTF. Emissions of air pollutants from FMEF are relatively small in comparison to those associated with FFTF supporting equipment. Therefore, all the air concentrations shown in Table 2–12 for Alternatives 2 through 5 are negative to represent an overall decrease in the emission of air pollutants.

Air quality concentrations for FFTF and FMEF were calculated with the SCREEN3 model developed by EPA. The model is intended to provide conservative estimates of the concentrations of air pollutants emitted from point or extended sources. Concentrations shown under Alternatives 2 through 5 were obtained by summing estimated emissions from the diesel-driven oil pumps, the oil-fired preheaters, and the gas turbine. Because

Table 2–12 Comparison Among Alternatives: Impacts on Criteria Air Pollutants at the Hanford Site

	Carbon Monoxide (micrograms per cubic meter)		Nitrogen Dioxide (micrograms per cubic meter)	PM_{10} (micrograms per cubic meter)		Sulfur Dioxide (micrograms per cubic meter)			
Averaging Period	8 hours	1 hour	Annual	Annual	24 hours	Annual	24 hours	3 hours	1 hour
Most Stringent Standard or Guideline[a]	10,000[b]	40,000[b]	100[b]	50[c]	150[c]	50[d]	260[d]	1,300[b]	660[d]
Options[e]	**No Action Alternative**								
All	0	0	0	0	0	0	0	0	0
Alternative 1: Restart FFTF									
1 & 4	52.1	74.4	0.012	8.4×10^{-4}	9.8	0.0008	9.1	20.5	22.8
2 & 5	52.1	74.4	0.012	8.4×10^{-4}	9.8	0.0008	9.1	20.5	22.8
3 & 6	52.1	74.4	0.012	8.4×10^{-4}	9.8	0.009	9.2	20.7	23.0
Alternative 2: Use Only Existing Operational Facilities									
1, 2, 4, 5, 7, & 8	-3.5	-5.1	-0.032	-0.002	-0.898	-0.164	-29.8	-67.0	-74.4
3, 6, & 9	-3.5	-5.1	-0.032	-0.002	-0.898	-0.155	-29.7	-66.8	-74.2
Alternative 3: Construct New Accelerator(s)									
1 & 2	-3.5	-5.1	-0.032	-0.002	-0.898	-0.164	-29.8	-67.0	-74.4
3	-3.5	-5.1	-0.032	-0.002	-0.898	-0.155	-29.7	-66.8	-74.2
Alternative 4: Construct New Research Reactor									
1 & 2	-3.5	-5.1	-0.032	-0.002	-0.898	-0.164	-29.8	-67.0	-74.4
3	-3.5	-5.1	-0.032	-0.002	-0.898	-0.155	-29.7	-66.8	-74.2
Alternative 5: Permanently Deactivate FFTF (with No New Missions)									
	-3.5	-5.1	-0.032	-0.002	-0.898	-0.164	-29.8	-67.0	-74.4

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 10 micrometers) standard is attained when the expected number of days with a 24-hour average concentration above the standard is equal to or less than 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. Federal standard currently under litigation.
d. State standard.
e. For descriptions of the options under each alternative, see Section 2.5.

Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995); additional data from Nielsen 2000.

these sources operate intermittently and do not necessarily operate at the same time, estimates of the concentrations of air pollutants shown in Table 2–12 are conservative because they were obtained under the assumption that all supporting equipment for FFTF would operate simultaneously, which is considered a worst-case scenario.

Generic Site for the New Accelerator(s). Under Alternative 3 (all options), air quality impacts at the site for the new accelerator(s) would result from the operation of emergency diesel generators for the high-energy accelerator and any support facilities. The low-energy accelerator would not require emergency diesel power, and it was assumed in the analysis that air quality effects of the low-energy accelerator could be ignored. Air quality impacts of the support facilities would be assessed if Alternative 3 (Construct New Accelerator[s]) were selected for implementation. Column 4 of **Table 2–13** shows estimated air pollutant concentrations at the

generic site that would result from operation of emergency diesel generators. In comparison with the air quality concentrations that would be expected during construction (Table 2–8), air quality impacts resulting from operation of the diesel generators would be relatively small. All of the expected concentrations resulting from operation of emergency generators would be small in comparison with the most stringent ambient air quality standards shown in column 3 of Table 2–13, and would not be expected to result in air pollutant concentrations in excess of ambient air quality standards. If the new accelerator(s) were located in an area that has high background pollutant concentrations, diesel emissions could result in pollutant concentrations in excess of the ambient standards. If Alternative 3 were selected for implementation, site-specific environmental documentation would be prepared prior to site selection.

Table 2–13 Air Pollutant Concentrations Expected from Operation of the Emergency Diesel Generators for the High-Energy Accelerator

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	94 135
Nitrogen oxide	Annual	100	0.47
PM_{10}	Annual 24 hours	50 150	0.03 17.7
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	0.03 16.5 37.2

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995); TechSource 2000.

Generic Site for the New Research Reactor. Under Alternative 4 (all options), air quality impacts at the site for the new research reactor would result from the operation of emergency diesel generators for the reactor. Column 4 of **Table 2–14** shows estimated air pollutant concentrations at the generic site that would result from operation of emergency diesel generators. In comparison with the air quality concentrations that would be expected during construction (Table 2–9), air quality impacts resulting from operation of the diesel generator would be relatively small. All of the expected concentrations resulting from operation of the emergency generator would be small in comparison with the most stringent ambient air quality standards shown in column 3 of the Table 2–14, and would not be expected to result in air pollutant concentrations in excess of ambient air quality standards. If the new research reactor were located in an area that has high background pollutant concentrations, diesel emissions could result in pollutant concentrations in excess of the ambient standards. If Alternative 4 were selected for implementation, site-specific environmental documentation would be prepared prior to site selection.

Table 2–14 Air Pollutant Concentrations Expected from Operation of the Emergency Diesel Generator for the New Research Reactor

Criteria Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	89.5 128
Nitrogen oxide	Annual	100	0.198
PM_{10}	Annual 24 hours	50 150	0.0035 3.46
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	0.062 61.2 138

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995); data from Appendix E.

2.7.1.5 Socioeconomics

As discussed in Chapter 4, implementation of the nuclear infrastructure alternatives would have no significant impact on regional economic areas or community services at Hanford, INEEL, and ORR. Socioeconomic impacts at the generic sites could not be evaluated in detail because areas potentially affected under Alternatives 3 and 4 could vary widely in demographic and economic composition. If Alternatives 3 or 4 were selected for implementation, site-specific environmental analysis would be conducted prior to site selection. **Table 2–15** shows the number of direct jobs that would be generated under implementation of the nuclear infrastructure alternatives. Deactivation of FFTF under Alternatives 2 through 5 would result in the loss of 242 jobs that are required to keep the facility in standby condition. That loss would be offset under alternatives and options for which FMEF would support the production of plutonium-238 (62 direct jobs).

2.7.1.6 Transportation Impacts

As stated in Section 2.4.2 and explained in Section 4.2.1.1, the transportation impacts for Option 1 of the No Action Alternative are those resulting from transporting 175 kilograms (385 pounds) (5 kilograms [11 pounds] per year for the 35-year evaluation period) of plutonium-238 from Russia to LANL. The impacts were obtained by extrapolating the impact analysis presented in the *Environmental Assessment of the Import of Russian Plutonium-238* (DOE 1993) for the purchase of 40 kilograms (88.2 pounds) of plutonium-238. The impacts presented for the other options of the No Action Alternative include those of Option 1 plus the impact from transporting neptunium oxide from SRS to the selected facilities at ORNL, INEEL, and Hanford. Because the assumptions and data used to assess the transportation impacts in the above environmental assessment are different from those used in this NI PEIS, incremental transportation impacts compared to the baseline condition (Option 1 of the No Action Alternative) can only be presented for the options under the No Action Alternative. Therefore, the transportation impacts presented in this section are not compared to the baseline condition.

Radiological and nonradiological transportation impacts over the 35-year program duration are summarized in **Table 2–16**. Risks to the public and workers due to incident-free transportation are shown in columns 3 through 5 of the table. Columns 6 and 7 summarize radiological and nonradiological risks to the public that could result from transportation accidents. Chapter 4 and Appendix J discuss transportation impacts in more detail.

Table 2–15 Comparisons Among Alternatives: Change in Direct Jobs Under the Nuclear Infrastructure Alternatives

Options[a]	Oak Ridge Reservation	Idaho National Engineering and Environmental Laboratory	Hanford Site	Generic Accelerator(s) Site(Construction/ Operation)	Generic Research Reactor Site(Construction/ Operation)
No Action Alternative					
All	0	0	0	0	0
Alternative 1: Restart FFTF					
1 & 4	41	0	218	0	0
2 & 5	0	24	218	0	0
3 & 6	0	0	292	0	0
Alternative 2: Use Only Existing Operational Facilities					
1, 4, & 7	41	0	-242	0	0
2, 5, & 8	0	24	-242	0	0
3, 6, & 9	0	0	-180	0	0
Alternative 3: Construct New Accelerator(s)					
1	41	0	-242	410/225	0
2	0	24	-242	410/225	0
3	0	0	-180	410/225	0
Alternative 4: Construct New Research Reactor					
1	41	0	-242	0	160/120
2	0	24	-242	0	160/120
3	0	0	-180	0.00	160/120
Alternative 5: Permanently Deactivate FFTF (with No New Missions)					
	0	0	-242	0	0

a. For descriptions of the options under each alternative, see Section 2.5.

RADIOLOGICAL TRANSPORTATION RISKS

Figure 2–27 illustrates the data listed in column 6 of Table 2–16. The results indicate a large risk to the public due to transportation accidents that could occur over 35 years under implementation of Alternatives 1 (Restart of FFTF), 3 (Construct New Accelerator[s]), and 4 (Construct New Research Reactor) as compared to those from implementation of Alternative 2 (Use Only Existing Operational Facilities). This large difference is due to the more than 8,000 medical isotope shipments by air transport considered under Alternatives 1, 3, and 4, and not under Alternative 2. As explained in Appendix J and the Transportation sections in Chapter 4, nearly all of the radiological and traffic accident risk are due to those involving medical and industrial isotope shipments. No enhancement of medical and industrial isotope production is considered under Alternative 2.

Implementation of Alternative 5 (Permanently Deactivate FFTF [with No New Mission]) would not result in any new transportation activities.

Table 2–16 Comparison Among Alternatives: Impacts of Transportation on Occupational and Public Health and Safety

Options[a]	Transportation Distance (millions of kilometers)	Incident-Free Transportation over 35 Years			Transportation Accidents over 35 Years	
		Public: Radiological (LCF)	Workers: Radiological (LCF)	Public: Vehicle Emissions (fatalities)	Public: Radiological (LCF)	Public: Vehicle Collisions[b] (fatalities)
No Action Alternative						
1	0.11	0.010	0.0046	4.7×10^{-4}	4.4×10^{-4}	0.014
2	0.13	0.011	0.0047	5.9×10^{-4}	4.4×10^{-4}	0.014
3	0.20	0.014	0.0049	8.9×10^{-4}	4.4×10^{-4}	0.014
4	0.22	0.014	0.0050	9.2×10^{-4}	4.4×10^{-4}	0.014
Alternative 1: Restart FFTF						
1 and 4	8.0	0.149	0.012	0.030	0.53	0.19
2 and 5	6.2	0.044	0.008	0.024	0.53	0.13
3 and 6	5.6	0.009	0.007	0.023	0.53	0.12
Alternative 2: Use Only Existing Operational Facilities						
1	2.2	0.120	0.005	0.0064	4.4×10^{-5}	0.059
2	0.15	0.004	0.001	0.0007	2.1×10^{-5}	6.0×10^{-4}
3	0.83	0.040	0.002	0.0014	3.0×10^{-5}	0.017
4	2.6	0.150	0.006	0.0056	4.4×10^{-5}	0.074
5	3.1	0.179	0.007	0.0066	2.1×10^{-5}	0.088
6	3.6	0.205	0.008	0.0075	3.0×10^{-5}	0.100
7	1.8	0.096	0.004	0.0052	4.4×10^{-5}	0.048
8	0.99	0.052	0.002	0.0030	4.4×10^{-5}	0.024
9	1.6	0.084	0.004	0.0037	3.0×10^{-5}	0.039
Alternative 3: Construct New Accelerator(s)						
1	5.7	0.054	0.008	0.023	0.53	0.14
2	5.8	0.057	0.008	0.023	0.53	0.14
3	5.9	0.065	0.009	0.023	0.53	0.14
Alternative 4: Construct New Research Reactor						
1	7.5	0.154	0.011	0.026	0.53	0.19
2	7.5	0.157	0.012	0.026	0.53	0.19
3	7.9	0.177	0.012	0.027	0.53	0.19
Alternative 5: Permanently Deactivate FFTF (with No New Missions)						
	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]	NA[c]

a. For descriptions of the options under each alternative, see Section 2.5
b. No radiological spill.
c. No new transportation activities would occur under Alternative 5.

Key: LCF, latent cancer fatalities.

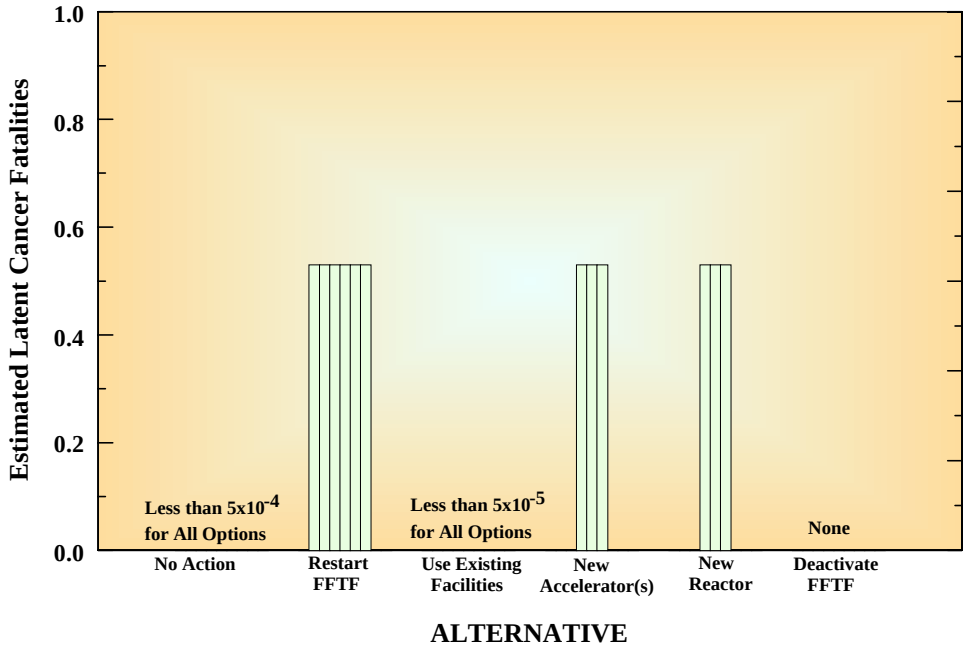

Figure 2–27 Public Risks Due to Radiological Transportation Accidents (35 Years)

Figure 2–28 shows the radiological risks to the public that could result from incident-free transportation over 35 years (column 3 of Table 2–16). For all of the alternatives and options, incident-free radiological transportation risks are approximately 0.2 latent cancer fatality over 35 years. As shown in column 4 of Table 2–16, radiological risks to workers due to incident-free transportation are less than approximately 0.012 latent cancer fatality for all alternatives and options.

NONRADIOLOGICAL TRANSPORTATION RISKS

Column 7 of Table 2–16 shows the risks of traffic fatalities that would be expected to result from vehicular collisions in which there is no radiological spill. Under all alternatives and options, the expected number of traffic fatalities would be less than approximately 0.2. Data listed in column 5 of the same table indicates that less than approximately 0.03 fatality would be expected from vehicular exhaust emissions. Fatalities that would be expected to result from both vehicular collisions and exhaust emissions are closely correlated with the estimated highway mileage that would be traveled under implementation of the alternatives (see column 2 of Table 2–16 and **Figure 2–29**). As discussed in Appendix J, traffic accident rates depend on the type of carrier. Both commercial trucks and DOE's SST/SGTSs would be used for the highway transport of isotopes. Accident rates for the safe, secure trailer system are less than those for commercial trucks by at least a factor of five. As a result, expected collision fatalities for any option would increase the total distance traveled, but the impacts would also depend on relative amounts of transportation by commercial truck and the SST/SGTs.

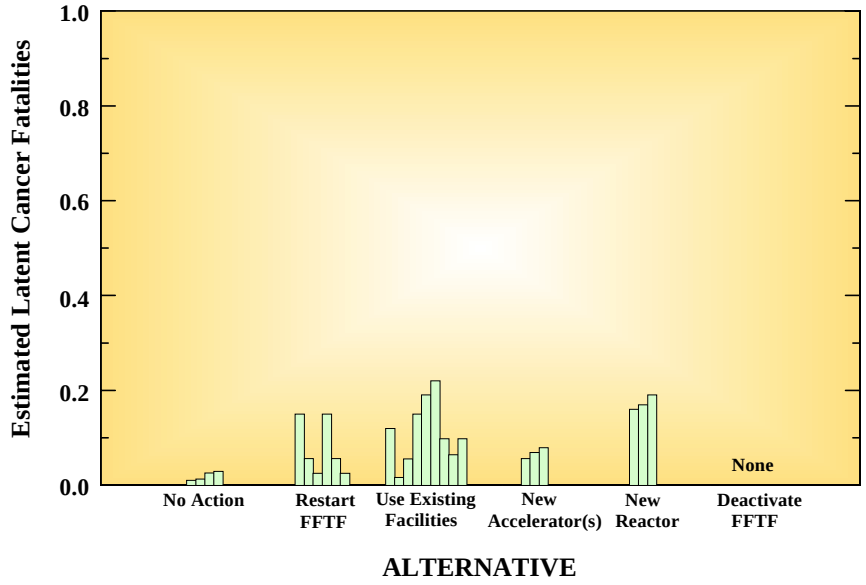

Figure 2–28 Radiological Risks to the Public Due to Incident-Free Transportation (35 Years)

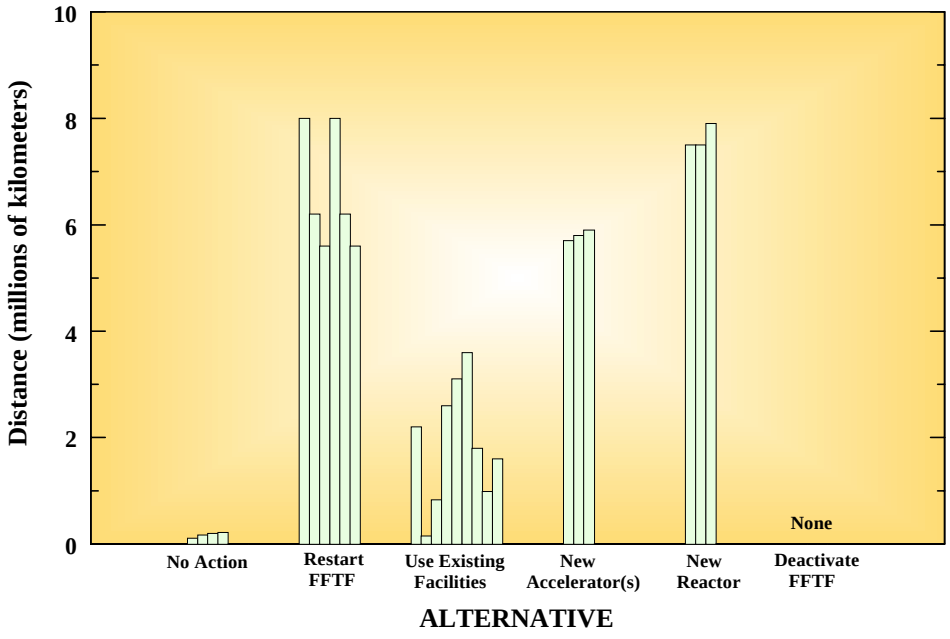

Figure 2–29 Highway Distances That Would Be Traveled Under the Alternatives (35 Years)

2.7.1.7 Resource Areas Discussed in Less Detail

As discussed in Chapter 4, implementation of the nuclear infrastructure alternatives at existing candidate sites would be expected to have little effect on land use, visual resources, noise, water quality, geology and soils, ecology, cultural resources, and environmental justice. Implementation of the alternatives at one or more generic sites could potentially result in significant impacts in one or more of these resource areas. However, these impacts are site-specific and could not be evaluated in detail in this programmatic document. If Alternative 2 (Options 4, 5, and 6), 3, or 4 were selected for implementation, site-specific environmental documentation would be prepared prior to site selection.

2.7.1.7.1 Land Use

Implementation of the nuclear infrastructure alternatives at existing operational candidate sites at Hanford, INEEL, and ORR would be consistent with ongoing activities and current land use at these sites. Irradiation of neptunium targets at an existing CLWR would also be consistent with the land use at the reactor site. If Alternatives 3 or 4 were selected for implementation, a site-specific evaluation of land use would be conducted prior to site selection. Deactivation of the FFTF under Alternatives 2 through 5 would have no effect on ongoing land use in the 400 Area of Hanford.

2.7.1.7.2 Visual Resources

Existing sites that are candidates for implementation of the nuclear infrastructure alternatives are rated Class IV under the U.S. Bureau of Land Management classification guidelines for visual resources (DOI 1986). Selection of one or more of the existing candidate sites for implementation would not affect their visual resource classification as areas in which industrial development dominates the landscape. Use of a CLWR for irradiation of neptunium targets would not alter the appearance of the reactor or the surrounding landscape. Implementation of Alternative 3 (Construct New Accelerator[s]) or 4 (Construct New Research Reactor) could result in reclassification under U.S. Bureau of Land Management guidelines. If Alternative 3 or 4 were selected for implementation, a site-specific evaluation of visual resources would be conducted prior to site selection. Deactivation of FFTF under Alternatives 2 through 5 would not significantly alter the overall landscape in the 400 Area of Hanford.

2.7.1.7.3 Noise

Noise associated with target fabrication and processing and irradiation at existing candidate sites would be similar to currently existing onsite noise and would not be audible beyond site boundaries. These activities would not produce sudden, loud noises that would startle wildlife. Noise levels that would be generated at a CLWR under Alternative 2 (options 4, 5, and 6) would be the same as those currently existing at the reactor site. Implementation of Alternative 3 (Construct New Accelerator[s]) or 4 (Construct New Research Reactor) would result in construction activities that could disturb nearby residents or wildlife. If Alternative 3 or 4 were selected for implementation, a site-specific NEPA review would be prepared, and an evaluation of potential noise impacts would be conducted prior to site selection. Deactivation of FFTF under Alternative 5 would not significantly alter the noise levels in the 400 Area of Hanford.

2.7.1.7.4 Water Quality

Under Alternative 1 (Restart FFTF), there would be no liquid radiological effluent pathways to the environment from FFTF. Process wastewater from cooling tower blow-down would be ultimately discharged to the 400 Area Pond (i.e., the 4608 B/C percolation ponds). No impact on the quality of ground or surface

water would be expected. Irradiation of neptunium targets at existing reactors and a generic CLWR would have no measurable effect on the quantity or quality of discharged effluents. Use of existing facilities for target fabrication and processing would not result in direct effluent discharge to the environment, and additional wastewater generation would be relatively small in comparison to existing wastewater treatment volumes at the sites. If Alternative 3 (Construct New Accelerator[s]) or 4 (Construct New Research Reactor) were selected for implementation, construction and operation of new facilities would not be anticipated to significantly impact water quality. While the water quality impacts are expected to be small, a site-specific environmental evaluation of potential water quality impacts and mitigation measures would be conducted prior to site selection. Sodium removal during deactivation of FFTF under Alternatives 2 through 5 would result in approximately 7,600 liters (2,000 gallons) of wastewater that would be disposed of in existing wastewater treatment facilities at Hanford. Deactivation of FFTF would not be expected to impact water quality.

2.7.1.7.5 Geology and Soils

Except for Alternatives 3 (Construct New Accelerator[s]) and 4 (Construct New Research Reactor), activities conducted under the nuclear infrastructure alternatives would not require construction of new facilities. No soil would be disturbed, and there would be no impacts on the geology of potentially affected sites. Construction of new accelerators and support facilities under Alternative 3 would be expected to disturb up to approximately 27 hectares (66 acres) of soil. If Alternative 4 were selected for implementation, construction of the new reactor and support facility would be expected to disturb approximately 4 hectares (10 acres) of soil. If Alternative 3 or 4 were selected for implementation, a site-specific environmental evaluation would be conducted prior to site selection. Deactivation of FFTF under Alternatives 2 through 5 would take place on previously disturbed land. Impacts of deactivation on geology and soils would be negligible.

2.7.1.7.6 Ecology

Activities that would be conducted under the nuclear infrastructure alternatives at candidate existing facilities and the generic CLWR would not involve construction of new facilities or significant changes in traffic, noise, air quality, or water quality. In addition, irradiation and processing activities would take place in established industrial areas. Impacts on terrestrial resources and wetlands would be negligible.

Under Alternatives 3 (Construct New Accelerator[s]) and 4 (Construct New Research Reactor), construction of new facilities at a yet-to-be-determined site could potentially have a significant effect on wildlife and wetlands. If Alternative 3 or 4 were selected for implementation, site-specific ecological evaluations would be conducted prior to site selection. The evaluation would include consultation with the U.S. Fish and Wildlife Service and appropriate state authorities concerning threatened and endangered species. Deactivation of FFTF under Alternatives 2 through 5 would take place on previously disturbed land in the 400 Area. No threatened or endangered species are known to reside in the 400 Area, and noise impacts on local wildlife would be temporary.

2.7.1.7.7 Cultural Resources

Existing candidate facilities that would host activities under the nuclear infrastructure alternatives are located within areas that contain National Historic Landmarks or structures that are eligible for nomination to the National Register of Historic Places. Several candidate facilities are eligible for nomination to the National Register, including the Reactor Containment Building and the Control Building for FFTF at Hanford, RPL at Hanford, and ATR at INEEL. Selection of these facilities to support the nuclear infrastructure missions would not alter their eligibility.

Under the nuclear infrastructure alternatives, activities at candidate existing sites and the generic CLWR would be conducted within existing facilities. Use of the FMEF at Hanford for target fabrication and processing would require construction of a 76-meter-high (250-feet-high) stack on previously disturbed land. Similarly, construction of a support facility for deactivation of the FFTF would take place on previously disturbed land in the 400 Area. Thus, except for Alternatives 3 (Construct New Accelerator[s] and 4 (Construct New Research Reactor), no disturbance of archeological resources would be expected under the nuclear infrastructure alternatives.

Implementation of Alternative 3 or 4 would require construction on potentially undisturbed lands. If Alternative 3 or 4 were selected for implementation, a site-specific NEPA review would be prepared, and an environmental evaluation of cultural resources would be conducted prior to site selection. The evaluation would include consultation with State Historic Preservation Offices and potentially affected Native American tribes.

2.7.1.7.8 Environmental Justice

The objective of the environmental justice analysis was to determine whether or not implementation of the nuclear infrastructure alternatives would result in significant environmental impacts that disproportionately affect low-income or minority populations. As discussed throughout Chapter 4, normal operations at the candidate sites and incident-free transportation pose no significant radiological risks to the public or to maximally exposed offsite individuals among the public.

Portions of the Fort Hall Indian Reservation and the Yakama Indian Reservation lie within potentially affected areas surrounding INEEL and Hanford, respectively. As discussed in Appendixes H and I, calculations of radiological risks considered human exposures due to inhalation and ingestion of radioactive materials. Ingestion of contaminated fish, vegetation, and/or wildlife is an environmental justice consideration due to potential patterns of subsistence consumption for minority or low-income populations (CEQ 1997:sec 4-4). Radiological health models used in the environmental evaluation assumed accidents at the irradiation facilities or the fabrication and processing facilities would contaminate all of the food produced in the area, and that all of the contaminated food would be consumed by persons residing in the potentially affected area. As discussed in Sections K.5.1 through K.5.3, the expected risk that would result from ingestion of radiologically contaminated food for persons residing near Hanford would be approximately 0.004 latent cancer fatality and essentially zero for persons residing near the INEEL or ORR. Thus, no credible pattern of food consumption would be expected to result in a significant health risk to low-income or minority populations residing within potentially affected areas surrounding the existing candidate sites. As explained in various parts of Section 2.7.1 and detailed in Chapter 4, implementation of the alternatives would not be expected to result in significant environmental impacts in any of the environmental resource areas. Thus, no disproportionately high and adverse impacts on minority and low-income populations would be expected to result from implementation of the alternatives.

As discussed in Chapter 4, accidents at candidate fabrication and processing facilities and during transportation of radioisotopes by aircraft were found to pose the largest risks to the public. Under conservative assumptions described in Appendix I, no latent cancer fatalities due to accidents would be expected at the existing sites. Accidents during air transport of radioisotopes could occur anywhere along the flight path and would not place any identifiable group within the general population at disproportionate risk.

The density and distribution of total, low-income, and minority populations varies from site to site, so that evaluations of environmental justice are necessarily site-specific. If Alternatives 3 (Construct New Accelerator[s]) or 4 (Construct New Research Reactor) were selected for implementation, a site-specific NEPA

review would be prepared, and an evaluation of environmental justice would be conducted prior to site selection. The evaluation would include patterns of food consumption that could result in disproportionately high and adverse effects on low-income or minority populations at risk.

2.7.1.8 Industrial Safety

Estimates of potential industrial impacts to workers during construction, irradiation, fabrication and processing were evaluated based on DOE and Bureau of Labor Statistics data. Impacts are classified into two groups: total recordable cases and fatalities. A recordable case includes work-related death, illness, or injury which resulted in loss of consciousness, restriction of work or motion, transfer to another job, or required medical treatment beyond first aid. The industrial safety evaluation is discussed in more detail in Section I.3.

The average occupational total recordable cases and fatality rates for construction and operation activities are presented in **Table 2–17**.

Table 2–17 Average Occupational Total Recordable Cases and Fatality Rates (per worker-year)

Labor Category	Total Recordable Cases	Fatalities
Construction	0.053	1.3×10^{-4}
Operation	0.033	1.3×10^{-5}

The expected impacts (both annual and for the duration of the activity) to workers at each facility for construction and operation are presented in **Table 2–18**.

Table 2–18 Industrial Safety Impacts from Construction and Operation

Facility	Estimated Number of Workers	Construction or Operation Duration (years)	Expected Annual Total Recordable Cases	Expected Activity Duration Total Recordable Cases	Annual Fatalities	Activity Duration Fatalities
Construction						
Low-energy accelerator	75	3	4.0	12	0.010	0.030
High-energy accelerator	410	5	22	110	0.057	0.285
New research reactor	160	7	8.5	59.5	0.022	0.154
Operation						
ATR[a]	0	35	–	–	–	–
HFIR[a]	0	35	–	–	–	–
CLWR[a]	0	35	–	–	–	–
FFTF	242	35	8.0	280	0.0031	0.109
Low-energy accelerator	13	35	0.4	14	1.7×10^{-4}	0.00595
High-energy accelerator	225	35	7.4	259	0.0029	0.102
New research reactor	120	35	4.0	140	0.0016	0.056
REDC	116	35	3.8	133	0.0015	0.0525
FDPF	75	35	2.5	87.5	9.8×10^{-4}	0.0343
FMEF	105	35	3.5	123	0.0014	0.049
RPL/306–E	30	35	1.0	35	3.9×10^{-4}	0.0137
New support facility	100	35	3.3	116	0.0013	0.0455

a. No additional workers would be required for the proposed activities evaluated in this NI PEIS.

No fatalities would be expected from either construction or operation of any facility.

2.7.2 Implementation Schedule

The implementation schedules for the alternatives in this NI PEIS are presented in **Figures 2–30** through **2–35**.

No Action Alternative

The implementation schedule for the No Action Alternative is shown in **Figure 2–30**. As indicated, the design and construction for the storage facilities would start during fiscal years 2001 and 2002 and would be completed during fiscal year 2004. Neptunium-237 shipments from SRS would take place during fiscal years 2005 to 2007. The purchase of plutonium-238 from Russia would start during fiscal year 2001.

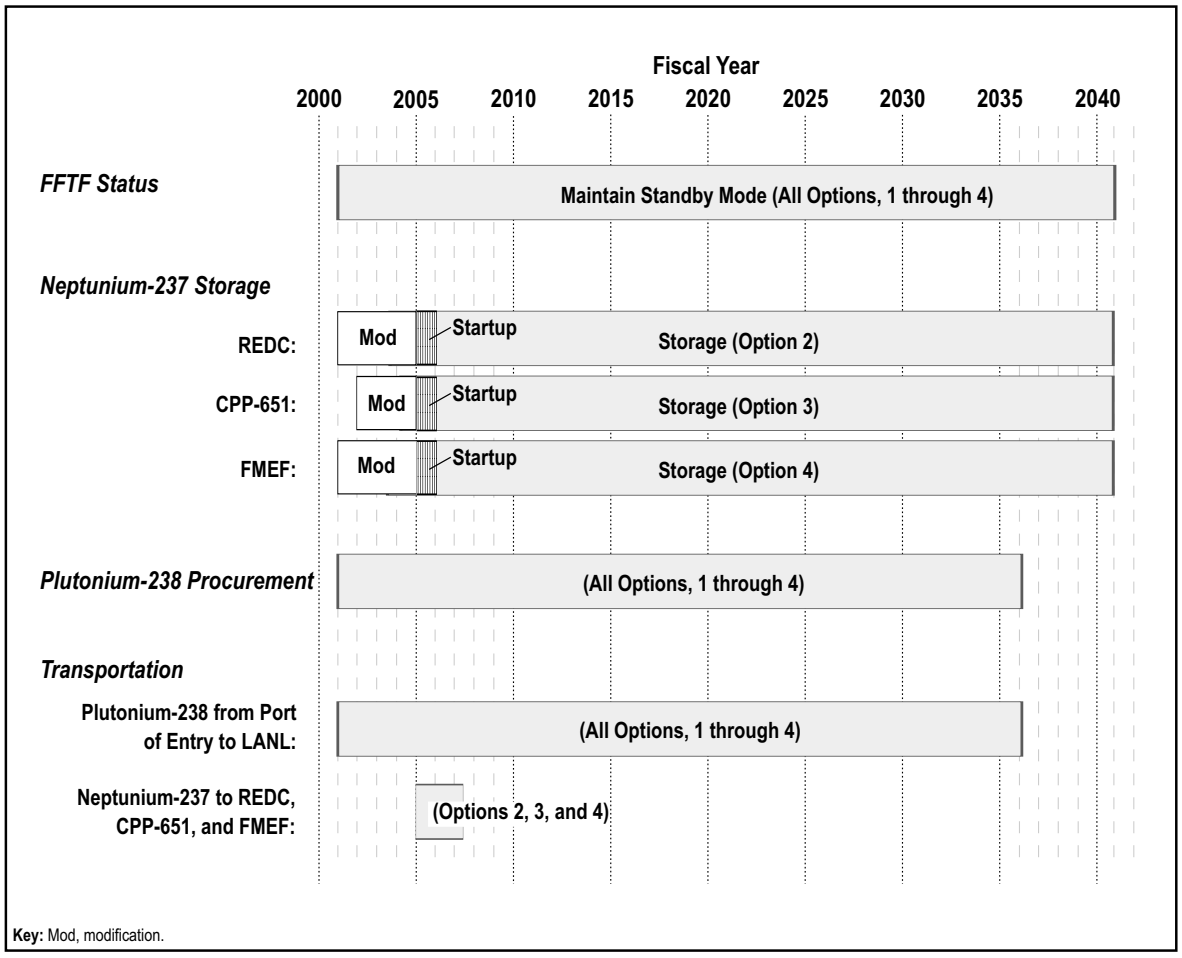

Figure 2–30 Implementation Schedule for No Action Alternative

Alternative 1—Restart FFTF

The planned implementation schedule for Alternative 1 is shown in **Figure 2–31.** As indicated, facility modification, design, and construction at target fabrication and processing facilities would take place during fiscal years 2001 to 2005.

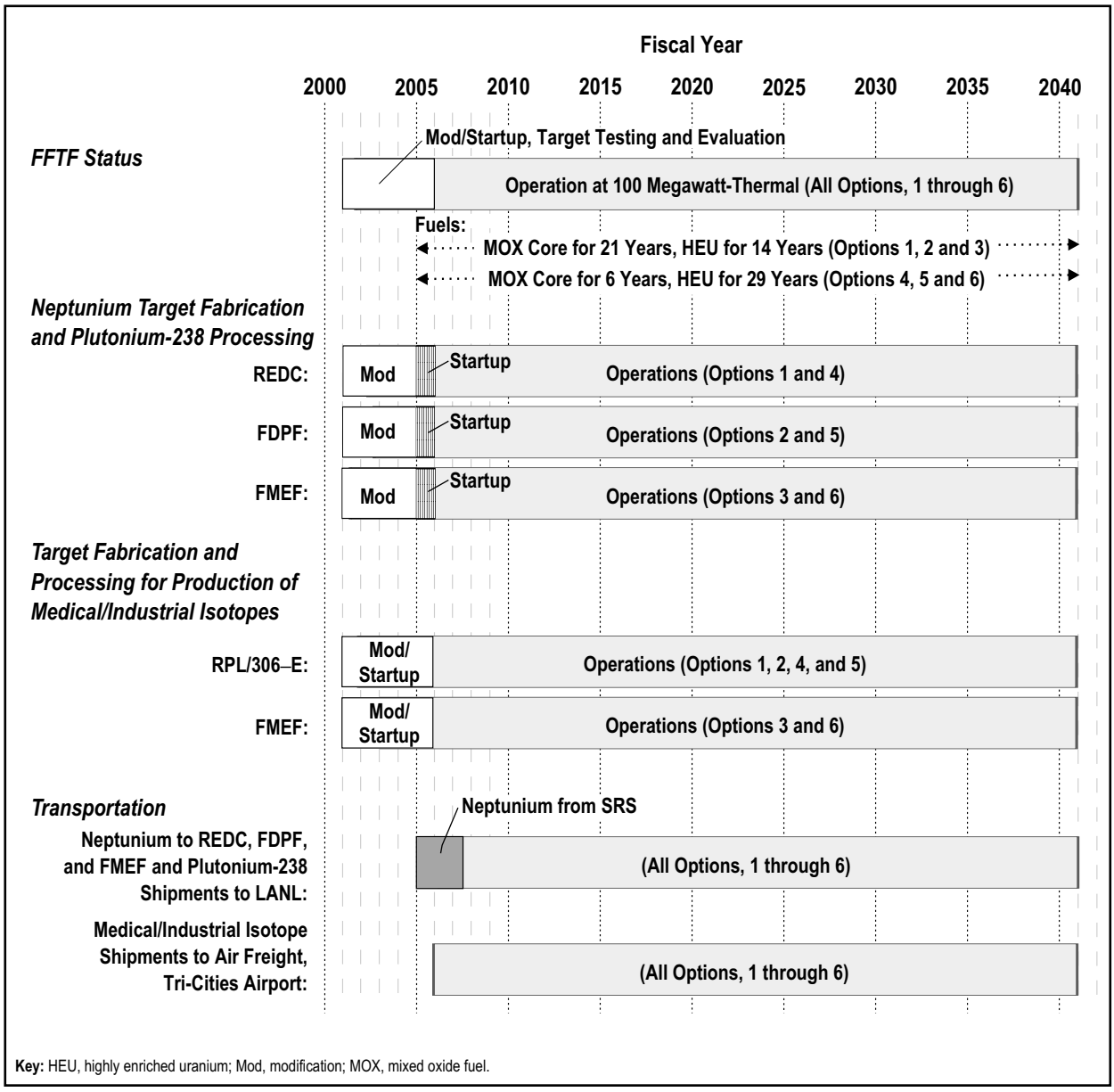

Figure 2–31 Implementation Schedule for Alternative 1

As shown in Figure 2–31, target fabrication and processing at REDC, FDPF, and FMEF were assumed to begin in fiscal year 2006 and would continue through fiscal year 2040 in conjunction with target irradiation at FFTF. Target testing and evaluation and facility testing and startup were assumed to take place in fiscal year 2005 at FFTF.

Alternative 2—Use Only Existing Operational Facilities

The planned implementation schedule for Alternative 2 is shown in **Figure 2–32.** As indicated, facility modification, design, and construction at storage and target fabrication and processing facilities would take place during fiscal years 2001 to 2004. It was assumed that reactor facilities would not require any modifications to irradiate targets.

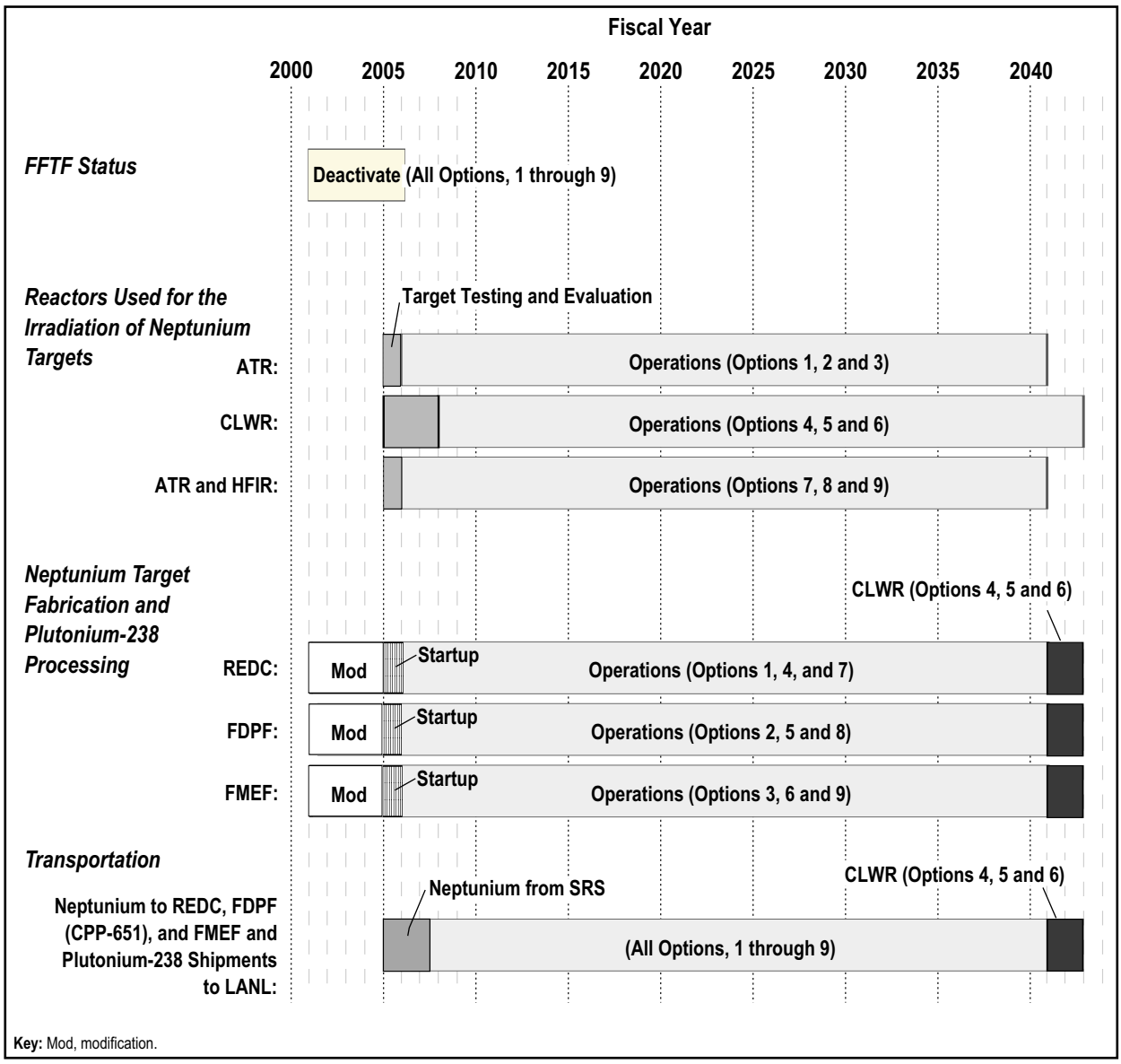

Figure 2–32 Implementation Schedule for Alternative 2

As shown in Figure 2–32, target fabrication and processing at REDC, FDPF, and FMEF were assumed to begin in fiscal year 2006 and would continue through fiscal year 2040 in conjunction with target irradiation at HFIR and/or ATR, and through fiscal year 2042 in conjunction with target irradiation at the CLWR. Target testing and evaluation and facility testing and startup were assumed to begin in fiscal year 2005 for each of the nuclear reactors and to continue to fiscal year 2006 at HFIR and/or ATR, and to fiscal year 2008 at the CLWR. Irradiation operations at nuclear reactor facilities would occur from fiscal year 2006 through fiscal year 2040 at HFIR and/or ATR, and from fiscal year 2008 through fiscal year 2042 at the CLWR.

Deactivation of FFTF would begin in fiscal year 2001 and continue through fiscal year 2006.

Alternative 3—Construct New Accelerator(s)

The planned implementation schedule for Alternative 3 is shown in **Figure 2–33**.

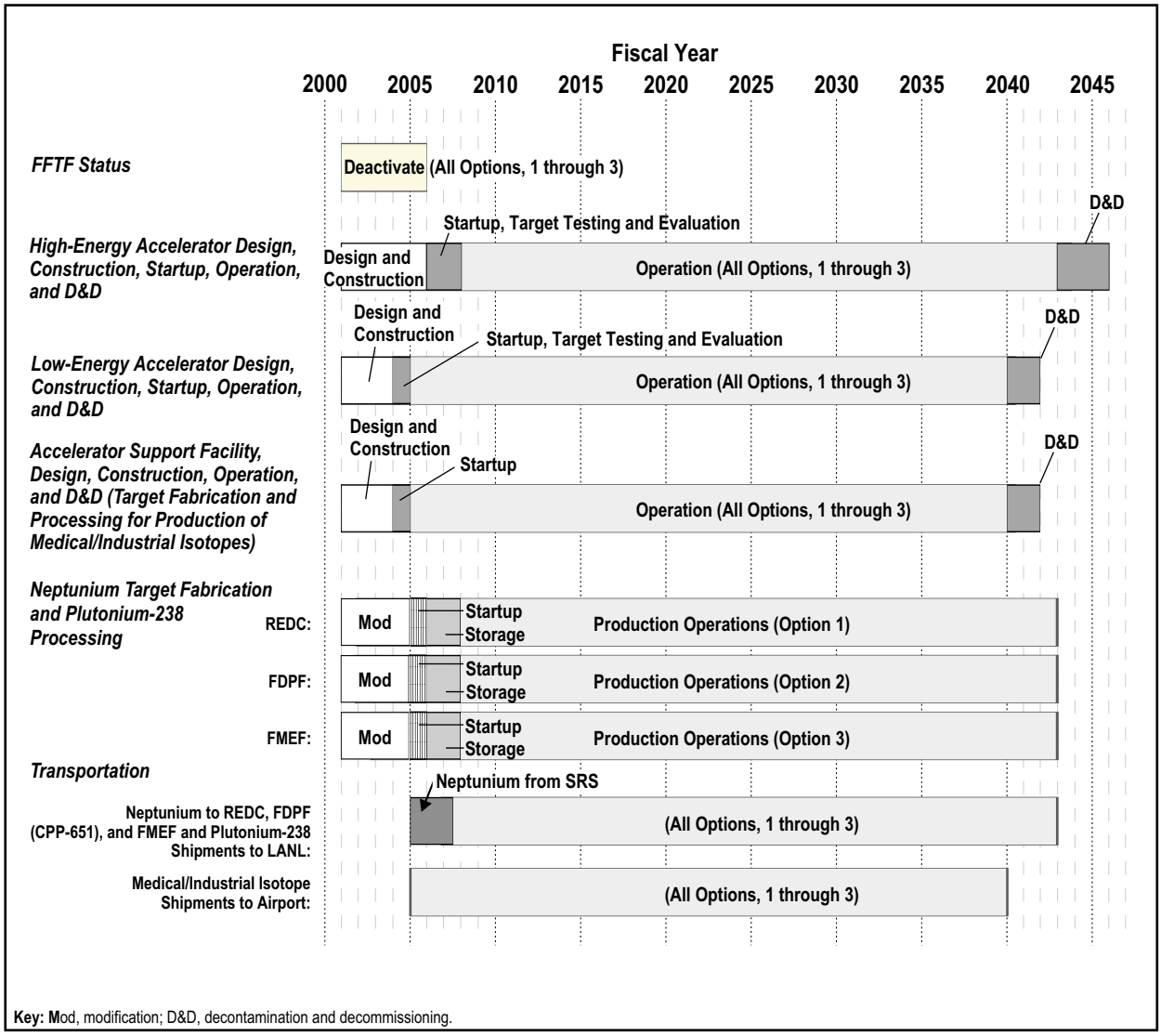

Figure 2–33 Implementation Schedule for Alternative 3

The new low-energy accelerator design and construction were assumed to begin fiscal year 2001 and continue to 2004, startup would be completed during fiscal year 2004, and full operation would commence fiscal year 2005. The new support facility schedule is driven by the reactor schedule and has similar schedule milestones. The new low-energy accelerator and support facility would be decontaminated and decommissioned within 2 years after completion of the missions.

As shown in Figure 2–33, the new high-energy accelerator design and construction were assumed to begin fiscal year 2001 and continue through 2006. The 2-year startup period would be completed during fiscal year 2007, and full operation would commence fiscal year 2008. The neptunium-238 target fabrication and processing facility (REDC, FDPF, or FMEF) modification design would take place during fiscal years 2001

to 2004 and start receiving neptunium-237 from SRS during fiscal year 2005. These facilities would be in full operation supporting the new high-energy accelerator irradiation of the neptunium-237 targets during fiscal year 2008. The new high-energy accelerator would be decontaminated and decommissioned within 3 years after completion of the mission.

Deactivation of FFTF would begin in fiscal year 2001 and continue through fiscal year 2006.

Alternative 4—Construct New Research Reactor

The planned implementation schedule for Alternative 4 is shown in **Figure 2–34**.

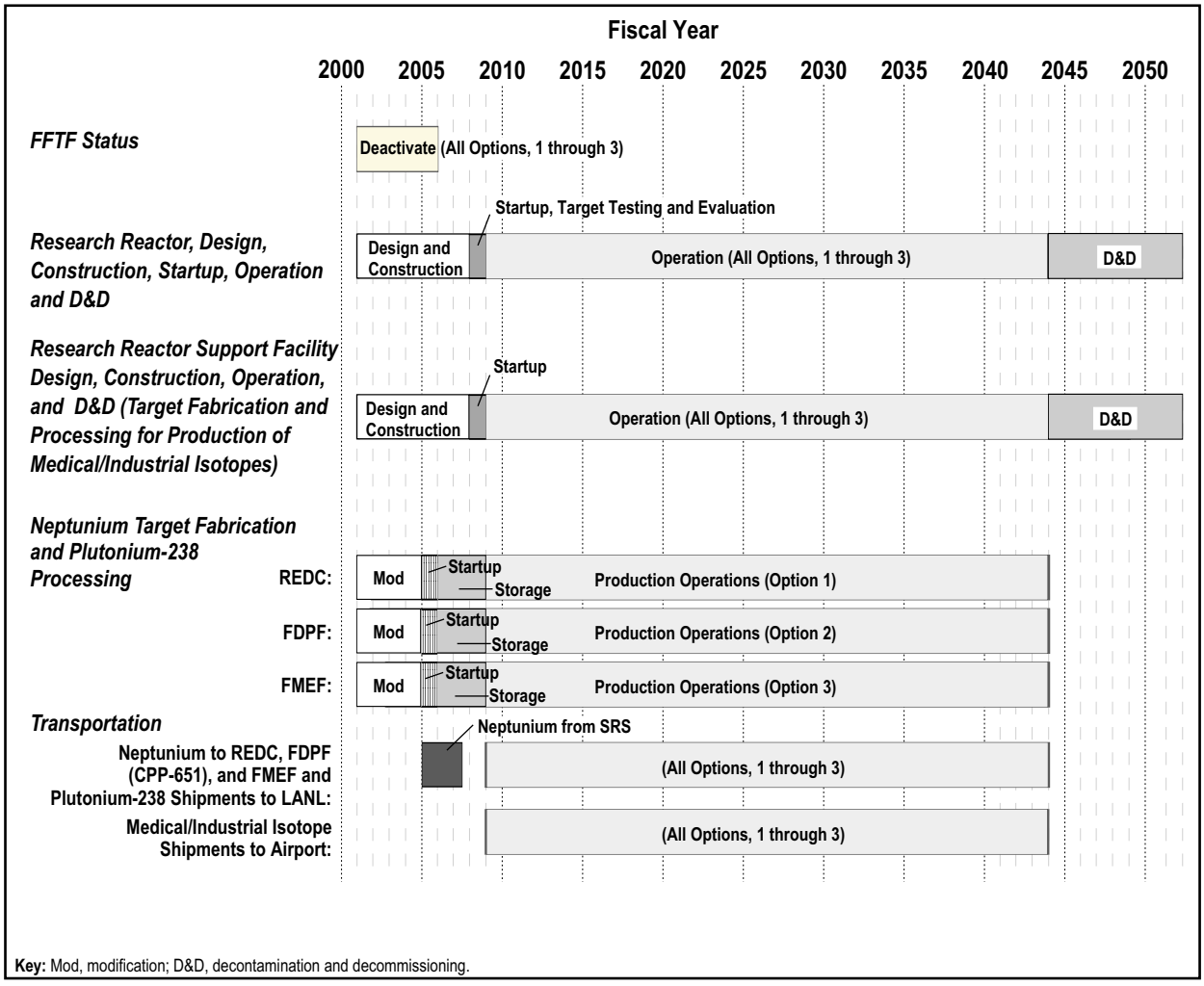

Figure 2–34 Implementation Schedule for Alternative 4

The new research reactor design and construction were assumed to begin fiscal year 2001 and continue to 2008, startup would be completed during fiscal year 2008, and full operation would commence fiscal year 2009. The new support facility schedule is driven by the reactor schedule and has similar schedule milestones.

As shown in Figure 2–34, the neptunium-238 target fabrication and processing facility (REDC, FDPF, or FMEF) modification design would take place during fiscal years 2001 to 2004 and start receiving neptunium-237 from SRS during fiscal year 2005. These facilities would be in full operation supporting the new reactor irradiation of the neptunium-237 targets during fiscal year 2009. The new research reactor and support facility would be decontaminated and decommissioned within 8 years after completion of the missions.

Deactivation of FFTF would begin in fiscal year 2001 and continue through fiscal year 2006.

Alternative 5—Permanently Deactivate FFTF (with No New Missions)

The planned implementation schedule for Alternative 5 is shown in **Figure 2–35.** As indicated, deactivation of FFTF would take place over 5 years (Battelle 1999).

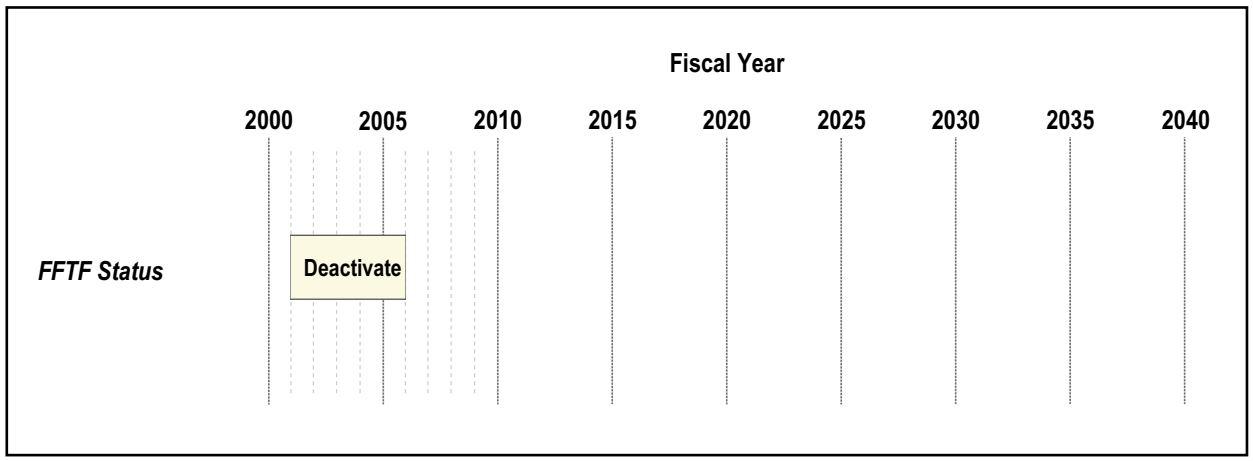

Figure 2–35 Implementation Schedule for Alternative 5

2.7.3 Comparison of Mission Effectiveness Among Alternatives

This section compares the effectiveness of Alternatives 1, 2, 3, and 4 in supporting the three missions evaluated in this NI PEIS:

- Medical and industrial isotope production
- Plutonium-238 production to support NASA space missions
- Nuclear energy research and development for civilian applications

Table 2–19 lists the medical isotopes that were included in the Expert Panel's forecast of future demands (Wagner et al. 1998), and identifies their means of production using accelerators, reactors, or separation from existing stockpiles of radioisotopes. Consistent with the panel's report, the list of isotopes is presented in three categories: proven medical isotopes currently used in clinical applications, those under development for clinical applications, and radioisotopes that have shown promise during medical research. Some are most suited for production in an accelerator, some in a nuclear reactor, and some are harvested by chemical separation from existing stockpiles of long-lived radioactive isotopes. Those isotopes that can be harvested from existing stockpiles of radioactive isotopes require only hot cells for the extraction process; neither accelerators or nuclear reactors are necessary for their production.

No single production method would satisfy all of the Expert Panel's projected requirements for medical isotopes. Isotopes produced by neutron capture are typically provided by a reactor, but could be produced by

Table 2–19 Medical Isotopes and Their Means of Production

Isotope[a]	Accelerator-Produced	Reactor-Produced	Separation from Existing Stockpiles of Radioactive Isotopes
Proven Isotopes Currently Used in Clinical Applications That Face Supply and Cost Concerns			
Yttrium-90	(b)	●	
Molybdenum-99[c]	(b)	●	
Indium-111	●		
Iodine-123	●		
Rhenium-186	(b)	●	
Developmental Isotopes for Clinical Applications That Face Availability and Cost Concerns			
Fluorine-18	●		
Phosphorus-32	(b)	●	
Krypton-81m	●		
Strontium-89	(b)	●	
Palladium-103	(b)	●	
Tin-117m	(b)	●	
Xenon-127	(b)	●	
Iodine-125	(b)	●	
Iodine-131	(b)	●	
Samarium-153	(b)	●	
Promising Research Isotopes That Are Not Being Explored Due to Lack of Availability or Cost			
Scandium-47	(b)	●	
Zinc-62	●		
Copper-64	●	●	
Copper-67	●	●	
Germanium-68	●		
Gadolinium-153	(b)	●	
Holmium-166	●	●	
Lutetium-177	(b)	●	
Rhenium-188	(b)	●	
Astatine-211	α		
Bismuth-212		●	●[d]
Bismuth-213	(b)	●	●[e]
Radium-223	(b)	●	●[f]

a. Wagner et al. 1998.
b. These isotopes are produced by neutron capture and could be produced in a high-energy accelerator. However, this capability has not been included in the design, analysis, or cost estimates of Alternative 3.
c. Sufficient supplies of this isotope are available from Canadian suppliers.
d. Bismuth-212 is a progeny of thorium-232.
e. Bismuth-213 is a progeny of uranium-233.
f. Radium-233 is a progeny of protactinium-231.

Key: α, efficient means of production with an alpha particle accelerator; ●, efficient means of production.

a high-energy accelerator with a spallation neutron source. Accelerator production of these isotopes would be relatively inefficient, and might not be practical to provide the large quantities needed to meet clinical demands. The proposed high-energy accelerator described in this NI PEIS could be modified to provide such capability, but this would add to the design, construction, and operating complexity, would require an increase in particle energy greater than 1 gigaelectron volts, and would increase the capital and operating costs.

Bismuth and radium isotopes, which were identified as promising medical isotopes by the Expert Panel, are currently harvested from existing stockpiles of long-lived radioisotopes and can also be readily produced in a reactor.

Alternative 1—Restart FFTF

FFTF would produce high-energy neutrons and a large flux level (10^{15} neutrons per square centimeter per second) that can be tailored to nearly any desired energy level. FFTF would provide the greatest flexibility for both isotope production and nuclear-based research and development among the baseline configurations for all of the proposed alternatives. Due to its large core size, flux spectrum, demonstrated testing capability, and rated power level, it would be able to concurrently support the projected plutonium-238 needs, production of medical and industrial isotopes, and civilian nuclear energy research and development related to a broad range of materials, advanced reactors, advanced fuels, and waste transmutation.

Alternative 2—Use Only Existing Operational Facilities

Due to current mission commitments at the existing DOE facilities, a large portion of the reactor irradiation space is committed to existing users. The existing reactors are able to provide for the current plutonium-238 needs. However, fulfilling this requirement with these facilities would use most, if not all, excess capacity, and may require some non-Federal missions to be terminated. The ability to expand the medical and industrial isotope production would require some current missions to be postponed or terminated. If the CLWR were used for plutonium-238 production, then the existing facilities would gain additional margin for medical and industrial isotope production and limited civilian nuclear energy research and development activities. These facilities have primary missions with sponsors who reserve the right to dictate to what degree and the times the facility could be used.

Alternative 3—Construct New Accelerator(s)

One or two accelerators, a low-energy accelerator and/or a high-energy accelerator, are proposed for Alternative 3. The low-energy accelerator would serve as a dedicated isotope production facility. Due to the nature of this type of accelerator, it could only produce a limited number of the isotopes listed in Table 2–19, it has no ability to satisfy the plutonium-238 needs, and a limited ability to support the proposed nuclear-based research and development needs. The preconceptual design of the high-energy accelerator presented in Appendix F focused on supporting the plutonium-238 production mission. The design of the high-energy accelerator could be refined and expanded to perform additional missions such as the production of a select set of medical and industrial radioisotopes. In addition, DOE is aware of longer-term concepts that would apply high-energy accelerators to produce "tuneable" neutrons in a subcritical assembly. Such a facility could be used to address some of the missions more familiar to reactor facilities and may hold considerable promise for future science and technology research. A facility of this nature could provide unique capabilities in areas such as the testing of many different nuclear system coolant, fuel, and material interactions. The changes required to add additional capability to the high-energy accelerator could be provided, but they would increase the size of the facility, add complexity to the facility design and operation, increase the cost of construction and operation, and potentially require more time for design and construction.

Alternative 4—Construct New Research Reactor

The proposed new research reactor would provide ample neutrons for the production of plutonium-238 and for many of the isotopes listed in Table 2–19. The thermal flux would limit the new research reactor's ability to produce a number of isotopes requiring fast or high-energy neutrons. Its lower flux levels (10^{13} neutrons per

square centimeter per second) and predominantly thermal flux would limit its ability to support many of the projected nuclear-based research and development needs.

2.8 PREFERRED ALTERNATIVE

The Council on Environmental Quality (CEQ) regulations require an agency to identify its preferred alternative(s) in the final programmatic environmental impact statement (40 CFR 1502.14(e)). The preferred alternative is the alternative that the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. Consequently, to identify a preferred alternative, DOE has developed information on potential environmental impacts, costs, policy issues, technical risks, and schedule risks for the alternatives under consideration. This NI PEIS provides information on the environmental impacts. Cost, nonproliferation policy, and various technical reports have also been prepared and are available in the appropriate DOE Reading Rooms for public review.

Based on the analysis discussed above, DOE's Preferred Alternative is to apply its existing infrastructure to the extent possible to pursue the missions outlined in this NI PEIS, that is, Alternative 2, Option 7. Under this approach, DOE proposes to consider opportunities to enhance its existing facilities to maximize the agency's ability to address future mission needs.

The Preferred Alternative also addresses the future of FFTF. While DOE recognizes that this facility has unique capabilities, the Department did not receive the commitments from the private sector or other governments that would clearly justify the restart of the facility. Lacking such commitment, DOE would permanently deactivate FFTF under the Preferred Alternative.

Finally, under the Preferred Alternative, DOE proposes to reestablish domestic production of plutonium-238, as needed, to support U.S. space exploration. ATR in Idaho and HFIR in Tennessee would be used, as appropriate, to irradiate targets for this purpose without interfering with either reactor's primary mission. The Preferred Alternative includes processing the irradiated plutonium-238 targets at REDC at ORNL.

In view of the lack of commitments that would justify the restart of FFTF or the construction of new facilities as proposed under Alternatives 3 and 4, DOE anticipates that its current infrastructure will serve the needs of the research and isotope communities for the next several years. In particular, DOE will consider opportunities to enhance its effort to provide medical and research isotopes. If significantly larger amounts of isotopes are required in the future, DOE would rely on the private sector to fulfill these needs.

As a potential option for the longer-term future, DOE proposes to work over the next 2 years to establish a conceptual design for an Advanced Accelerator Applications (AAA) facility. Such a facility, which would be used to evaluate spent fuel transmutation, conduct various nuclear research missions, and ensure a viable backup technology for the production of tritium for national security purposes, was proposed and initial work funded in the fiscal year 2001 Energy and Water Appropriation. If DOE proposes specific enhancements of existing facilities or development of the AAA facility, further NEPA review would be conducted.

2.9 REFERENCES

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10 CFR Part 73, "Physical Protection of Plants and Materials," U.S. Nuclear Regulatory Commission.

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40 CFR Section 1502.14e, "Alternatives Including the Proposed Action," Council on Environmental Quality.

49 CFR Part 173, "Shippers - General Requirements for Shipments and Packagings," U.S. Department of Transportation.

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